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SOUND REFLEXION AND REFRACTION.

By the Rev. JOHN M. BACON, M.A., F.R.A.S.

MORE than one recent disaster at sea, still unexplained, has pointed to the necessity of reconsidering certain accepted dogmas relating to the transmission of sound waves, and official reports of a disquieting nature from look-out stations have called once and again for serious investigation of the anomalous behaviour under special conditions of such sound signals as are commonly in use at sea. In particular it has been insisted on that the hearing of the syren and fog-horn is apt to prove uncertain and that, on occasions at least, there are to be found areas or zones of silence where their warning will unaccountably fade or else cease altogether to be heard.

It would appear, however, that this peculiarity is not by any means confined to the signals of those instruments of which the syren is the type. The writer has had special opportunities of experimenting with explosive signals of many kinds, and has on three separate occasions, and under very different circumstances, carried out systematic trials on the penetration of the service cotton-powder cartridge fired at different heights from balloons whilst travelling over diversified open country as also over populated districts including London itself. These trials have drawn records from a large number of independent observers, whose statements, when carefully analysed and compared, have proved beyond all reasonable doubt that even the most powerful and deservedly well trusted form of modern explosive signal is sometimes fickle in its character, failing or fading in unexpected quarters without obvious cause.

It will probably be readily conceded that the explanation of these facts must be sought not so much in any peculiarities in the sounds themselves as in the condition of the medium through which they are propagated, and it is here that the views expressed perhaps too confidently a generation ago may need to be modified. Certain conclusions as to states of atmosphere commonly affecting the passage of sound waves have perhaps remained too long unchallenged.

Thus Professor Tyndall states that while conducting experiments with sound signals at the South Foreland there were present always and in all weathers invisible acoustic clouds which returned echoes from the instruments and cannon planted on the summit of the cliff overhead. Hundreds of cannon-shots, he states, were fired, and were always followed immediately by a rumbling which the Professor asserted must have come only from out of the empty air. If this were so, then we must conceive that there was constantly present in the air some form of obstruction that not only impeded but reflected back the waves of sound that were being emitted.

It is with regard to this point that some results recently obtained may be deemed instructive. In the first place, although during the experiments in which I have been concerned some scores of cotton-powder signals have been fired from balloons under very different meteorological conditions, nothing of the nature of an aerial echo has ever been suspected, and the dead silence aloft has always been absolutely unbroken after each report until, after an interval of several seconds, the earth itself has replied with a burst of sound which has reached the car even at the height of a mile with all the intensity and reverberation of a thunder-clap. This striking result, invariably the same, appears highly significant, and would point to the conclusion that the initial report immediately consequent on a lightning flash is, like the fog-signal bursting below the car, comparatively speaking only a trivial sound, while the great uproar of sound must practically be wholly due to echo, which is presumably largely off the ground. In support of this I would state that when one of the signal cartridges already described is fired, say, 150 feet above the ground, in moderately open country, an observer below hears a series of extremely powerful echoes which he can easily trace to each clump of trees or building around, and several seconds after this elapse before the subsequent conflict of reverberations ceases. Further, when such a rocket signal has been fired over a wide extent of quiet common terminating at some distance in an abrupt decline, it has awoke surprising and unexpected echoes from woods lying in the valley, although these have been completely out of sight and sheltered from the ear by a considerable stretch of intervening level ground. In this case both the incident and reflected waves of sound had clearly been defracted or bent over the shoulder of the hill which hid the woods from view.

I would then submit, first, that a condition of atmosphere causing aerial echoes is by no means the normal condition, and, secondly, that the return of sound which Professor Tyndall, when stationed under the cliff, appeared

to hear almost instantly from the offing may in actual fact have been defracted from cliffs and headlands hard by but out of sight.

That aerial echoes are sometimes heard I would, as the result of my own experiences, very readily admit, and I would regard the condition of atmosphere favouring this phenomenon as one probable cause of that failure of sound at certain spots which has been already referred to.

But some other dogmatic statements which have already done service full long respecting the reflection of sound waves may well be questioned. Take the well-known example attributed to the Whispering Gallery of St. Paul's. Here, as I have pointed out elsewhere, the transmission of a whisper around the circular wall is obviously not due to reflection in the ordinary sense, as anyone may convince himself by testing the phenomenon in quiet night hours. Or, again, if on a calm day a smooth crescent-shaped surface similar to a segment of the Whispering Gallery be constructed in the open—as may be readily done by means, say, of a length of continuous stout brown paper stretched on battens—an experimenter will find that the Whispering Gallery effect can be produced under circumstances where reflection from an opposite surface is impossible. A whisper communicated either by the mouth or suitable instrument against such a curved surface appears to *course round* in close contact with the surface.

I would note that the description given by Sir John Herschel of the peculiar phenomenon of the Whispering Gallery, which has been copied and re-copied into every text-book, is obviously incorrect, and so also, as I am prepared with due permission to point out, is that relating to the echoes at Woodstock. From which I would gather that neither Herschel nor those who have quoted his words have ever investigated the phenomena in question.

In connection with echoes a very noteworthy result has presented itself in the course of the acoustic ballooning experiments in which I have been engaged—namely, that the echo from earth of exploding signals has been always and uniformly retarded. This result has been obtained and verified very many times by independent observers using carefully corrected instruments, and no doubt has been entertained of its truth. Whether, however, this retardation be due to a diminution in the rate of sound travelling vertically through the atmosphere or to any "dwell" or "lag" in the actual reflection of sound I am not at present prepared to state.

As suggesting a further cause possibly operative in the occasional local failure of sound signals, I would call in evidence certain experiences of my own with regard to the effect on sound of fog or cloud. Professor Tyndall insists that fog has no sensible power to obstruct sound, while air associated with fog being, as a general rule, highly homogeneous is favourable to the transmission of sound.

I am able to assert that this view is very far from being generally accepted by practical men employed on look-out stations, and it is entirely opposed to the statements of Stevenson and other eminent authorities. My own observations gathered in balloon voyages, and also during a sojourn of several days and nights, generously granted me by Trinity House, on the Maplin Lighthouse in thick weather, go to show that whereas a condition of still and settled fog may aid the travel of sound, compacted cloud-heaps or wreaths, and masses of rolling mist are capable of refracting and diverting sound waves in a manner that will deceive the most practised ears. For example, the warning of neighbouring light-ships' foghorns as heard from the Maplin are influenced in a far greater measure by the circumstances and qualities of intervening fog than by a gentle wind; moreover, a horn which had been nearly quenched by interposing mist has been observed to sound with far more than normal intensity as soon as the fog had rolled away behind, forming a background to gather and reflect the sound wave.

I would call attention to the fact that many accepted statements that have done duty in the past with regard to the travel of sound waves seem to have been based on the results of experiments conducted in the laboratory, and I would submit that a more unfavourable place for satisfactory experiments on sound could hardly be chosen, inasmuch as the six bounding surfaces must surely cause reflections seriously endangering the truth of results obtained. Conducting experiments of this kind must often rather resemble such a feat as trying to project lantern pictures in a room where walls, floor, and ceiling are all faced with brilliant mirrors.

THE MYCETOZOA, AND SOME QUESTIONS WHICH THEY SUGGEST.—V.

By the Right Hon. Sir EDWARD FRY, D.C.L., LL.D., F.R.S., and AGNES FRY.

ABERRANT FORMS.—Having thus given some description of the various parts of the Endosporous Myxies, we shall now revert to the aberrant forms which have hitherto been left out of consideration—viz., the Exosporous Myxies and the Acrasieæ, the position of which in the classification may be learned by again referring to the table given in an earlier paragraph.

EXOSPOREÆ.—The Exosporeæ, or Myxies which carry their spores on the surface and not in the inside of the sporangium, consist of one genus—*Ceratomyxa*—and of two species, or, according to other authorities, of one species only with one variety. Of this small organism a drawing will be found in Fig. 15. Its first describer, Micheli, called it *Puccinia ramosa* (in 1729). In 1805 it was called *Ceratium hydnoides* by Albertini and Schweinitz. It was described as *Ceratomyxa mucida* by Schrater in 1889, and, as that name is adopted by Mr. Lister, whose works are the most convenient for the English reader, we have thought it best to follow him. But we have given the synonyms to prevent our readers from being misled by the puzzling and lamentable variety of names.

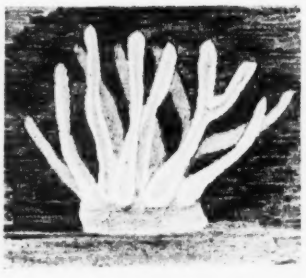

FIG. 15.—*Ceratomyxa mucida*. Magnified. (After Famintzin and Woronin.)

The *Ceratomyxa mucida* is by no means uncommon on rotten wood, and might at first sight be mistaken for a white or pale-coloured fungus. It consists of an aggregation of finger-like projections from a common base, and presents somewhat the appearance of a minute piece of white coral. When the surface of these projections is examined, it is found to be marked off by delicate lines into polygonal spaces, from the centre of each of which rises a delicate white stalk, and on the summit of this an equally delicate and white egg-shaped spore.

The development of this little organism has been elaborately studied by two Russian botanists, and it is sufficiently interesting to demand a few minutes' attention.

Its plasmodium emerges from the wood in points about the size of a pin's head, and is found to be differentiated into two elements—(1) a transparent motile jelly, and (2) an irregular network of opaque plasma embedded in the transparent jelly. These two parts are shown in Fig. 16.

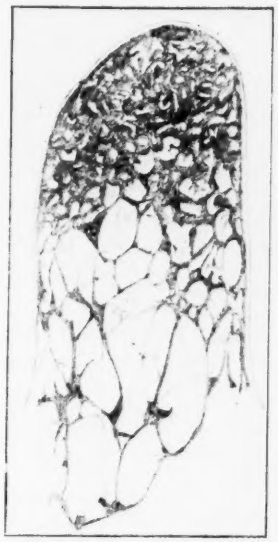

FIG. 16.—*Ceratomyxa mucida.* Plasmodium showing superficial transparent jelly, and opaque strands. (After Famintzin and Woronin.)

Gradually little prominences are developed on the surface of the plasmodium, and as these grow into the finger-shaped projections, the network of opaque plasma appears just below their surface, the translucent jelly of the interior passing through the strands of the network and forming a very thin external coat. The next step is taken when the strands of this network thicken so as to occupy nearly the whole surface of the projection and then break up into polygonal plates, each furnished with a nucleus; from each of these plates there grows a pedicel supporting a ball which is the future spore; into this the opaque plasma of the plate passes. This state of things is shown in Fig. 17. When the spores have fallen off, the rest the plant withers and disappears.

Each swarm spore, according to these authors, often shows amœboid movements; divides into two equal parts, which assume a cross-like posture in their greatest length, the one lying on the other; then each of the two parts divides into two other parts and again each of the four divides into two parts, so that the original swarm spore is now represented by eight protoplasts all lying together; these then separate, develop cilia, and act as free swarm spores. Fig. 18 represents the eight protoplasts lying crosswise together, before their final separation. We are bound to add that this peculiar process has not been noticed by Mr. and Miss Lister in their numerous observations on *Ceratomyxa*, nor by ourselves in our more limited ones, and the matter appears therefore to require further enquiry.

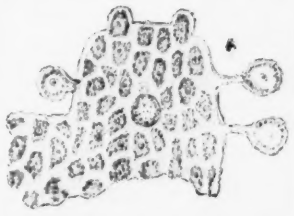

FIG. 17.—*Ceratomyxa mucida.* Development of Spores × 160. (After Famintzin and Woronin.)

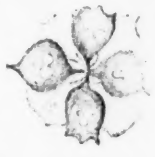

FIG. 18.—*Ceratomyxa mucida.* Eight Protoplasts before their final separation. (After Famintzin and Woronin.)

ACRASIEÆ.—We have already indicated the existence of a small group of organisms differing from the ordinary myxies in the fact that the swarm-spores, though they gather together and act together, never fuse into a single mass or constitute a true plasmodium.

Three species have been studied and described with some care, and their history is so curious that we hope our readers will not weary if we dwell upon it a little.

The swarm spores are like those of true myxies, and have the same amœboid movements, but without the dancing movement with flagellæ. These swarm-spores meet and, as if by common consent, set up a centre of attraction, towards which they tend, the long arms or straggling parts of the original gathering coming more and more to the central point.

The course of growth in *Acrasis granulata* (one of the organisms in question) has been described by Van Tieghem. When the swarm cells have gathered together, they touch one another, and form a cellular mass. This mass grows upwards in a conical shape. The cells of the axis, somewhat longer than they are broad, assume a cellular membrane, and constitute a foot, buttressed up by other cells. The exterior cells move upwards on this foot, clothe themselves with a cellular membrane, heap themselves together at the summit of the structure, and thus form a chaplet of spores.

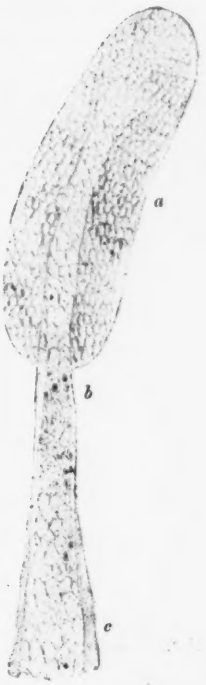

FIG. 19.—*Dictyostelium mucoroides.* Section. *a*, Crown of Spores; *b*, Stalk; *c*, Remains of Membrane broken by growth of the Sporangium. (After Brefeld.)

In *Dictyostelium mucoroides* a very similar course of growth has been observed. The mass which collects at the central point differentiates itself into a column, a membraneous veil to the column, and a residual mass surrounding the column. As the column grows upward this residual mass does the same, and thus withdrawing its lower part from the ground it wanders up the stalk and forms a cap or crown which turns into spores without a trace of capillitium. Fig. 19 shows in section the nearly adult form of this organism.

A still more singular history is presented by a third species, the *Polysphondylium violaceum*. Here the early stages correspond with those already described, the plasmodium, or more accurately the pseudo-plasmodium, gathers itself towards a central mass as shown in Fig. 20; the central mass again differentiates itself into a column and a surrounding mass of protoplasm which clings round the attenuated central column, as shown in Fig. 21; it then begins to narrow in at intervals along this column, and breaks up into discontinuous lengths with intervening nodes, as shown in Fig. 22 (*a*). From these discontinuous pieces of protoplasm there are subsequently developed in the top of the column a terminal head, and on the successive lower stages of the column, successive whorls of stalks, each carrying a lateral and smaller head, as shown in Fig. 22 (*b*); each of these heads finally ripens and breaks up into spores.

The life-history of all these *Acrasieæ* presents many very curious points; it seems to bring before us the fact that separate protoplasts, without ever uniting into a plasmodium or ever becoming part of a single organism, may nevertheless acquire as it were the social instinct and live for the good not of themselves but of the whole organism, and for that purpose may submit to a division of labour;

for whilst some of the protoplasts assume the function of only supporting their fellows, the others avail themselves of the support, raise themselves from the level of their original surface, and devote themselves to the function of reproduction. And, moreover, certain aberrant and sessile

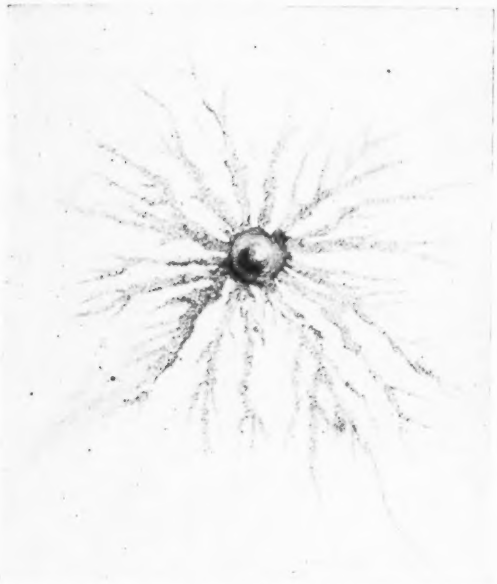

FIG. 20.—Pseudo-plasmodium of *Polysphondylium violaceum*. (After Brefeld.) × about 25.

forms of the *Dictyostelium* seem to show that this elevation of a portion of the protoplasm is not necessary to reproduction, though it may well be that the greater exposure to the ripening influences of the atmosphere and the sun may render it beneficial to the organism, and so more than compensate for the withdrawing from the function of reproduction of a certain part of the protoplasm, and applying it to the purposes of support alone.

UNICELLULAR ORGANISMS.—Leaving now the subject of classification, and of the aberrant forms of myxies, we return to the principal group. We have already dwelt upon the fact that the myxies show all their vital powers and all their capacity for development without the formation of a true cell-wall, or undergoing division by septa formed in cells. It seems scarcely possible for organisms living in the air to attain any considerable size or complexity of form without the support of cell-walls, and without the formation of vessels which assist the transfer of nourishment from one part to the other.

But with plants inhabiting the water—a medium of nearly the same specific gravity as the plant—and drawing their nourishment directly from this medium, the case is different, and the possibility of such organisms attaining considerable proportions and complexity of outward form is shown by a considerable group of *Algæ*, for which there has recently been formed a class called *Multinucleatæ*, which includes four orders with considerable differences amongst themselves, but which all agree in possessing no cell-walls, and, under ordinary conditions, no septum dividing one part from the other. Each organism is thus a single protoplast. These unicellular organisms, as they are often called, show a capacity for developing a vast diversity of forms, many of them very beautiful, and many of them strangely mimetic of the forms of higher plants—of the mosses, the lycopods, the conifers, the cactus tribe, and the hymenomycetous fungi. Some of these organisms reproduce sexually, others asexually; some attain very considerable size—as in the genus *Caulerpa*, a beautiful form of marine alga. "Nature," says Mr. Geo. Murray, speaking of *Caulerpa*, "appears to have executed in the form of this genus a *tour de force* in exhibiting the possibilities of the siphoneous thallus—in showing that it is possible for a unicellular organism to display the varied beauties of outward form characteristic of highly organised types, to attain by means of a lattice-work of cross beams within the cell body that mechanical support effected by transverse septa and separate differentiated cellular structures for other algæ and for the higher plants."

A consideration of these structures impresses the mind very forcibly with the vast inherent capacities of protoplasm. Nature had two courses open to her, if we may so speak, as to the mode of dealing with protoplasm—endowed as it is with its varied capacities—each of which she has pursued to a certain extent. In the one course of development the single protoplast has remained a unit, and has in this undivided condition performed all the needful work of the plant. In the other course, the protoplasm has been broken up into detached parts by the cell-walls, and thus a division of labour has been brought about or promoted which has led to the highest results, and left the unicellular organisms far in the rear. The former course of development is seen in the myxies, and, as we have shown, reached a great development both as regards size, form, and function, in such algæ as *Caulerpa*. The other course of development is seen of course in nearly all the other members of the vegetable kingdom, and reaches its highest results in such vast and complex organisms as our forest trees.

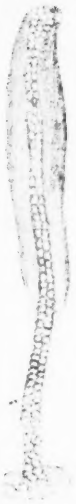

FIG. 21.—Immature Sporangium of *Polysphondylium violaceum*. (After Brefeld.)

One other observation naturally arises from the consideration of these unicellular forms. We are wont to trace the origin of the differentiation of parts—of the branches and leaves and so forth—to the divisions of the cell of the growing points in plants. We now see a differentiation of parts arising without any such cell to divide, and without any septa to mark off the future organ. The protoplasm is the master: the cell-walls are its humble servants, and we have another illustration of how the contents are apt to rule the containing structure, and the soft to rule and mould the hard. The divisions of the cell-walls are a secondary and subordinate phenomenon.

ISOMORPHISM.—We crave our readers' leave to return to the fact already mentioned, that unicellular organisms have a tendency to imitate the forms of cellular organisms, and that whereas we have in the series and chain of cellular plants such marked outward forms as those of the moss, the lycopod, the conifer, the cactus, &c., we have in the chain of unicellular plants very similar outward forms, so that we seem to have two chains branching off from one another, with links here and there which closely correspond with one another. This phenomenon is one found frequently to present itself to the attention of the philosophical systematist, and like all the phenomena of Nature is well worth pondering. It has been stated very forcibly by Mr. Brady, in respect to the *Foraminifera*, a group of organisms deeply studied by him:—"A

purely artificial classification is ill-adapted to the conditions presented by a class of organisms like the *Foraminifera*, largely made up of groups of which the modifications run in parallel lines. This 'isomorphism' . . . . . exists not merely between a single series in one of the larger divisions, and a single series in another, but often amongst several series, even of the same family. It not unfrequently happens that a member of one group presents a greater similarity to its isomorph in another group with which it has no relationship than it does to any other member of its own group. Take a familiar illustration: suppose the fingers of the two hands to represent the modifications (species) of two such parallel types of *Foraminifera*: the thumb of one hand resembles more closely the thumb of the other hand than it does any other of the fingers of its own."

FIG. 22.—*Polysphondylium violaceum*. *a* and *b* successive stages in ripening of Sporangium. (After Brefeld.)

A comparison of the marsupial quadrupeds of Australia and South America with the placental mammals of the rest of the world presents another series of these isomorphs. There are certain Marsupials which seem set over against the Carnivora, others against the Rodents, and so forth. Mr. Murray, in his "Geographical Distribution of Mammals," has figured on the same page two animals, one a small placental mouse, and the other a small marsupial mouse, and their outward forms are almost indistinguishable; and yet the common parent of the two forms must be sought, according to our present notions of phylogeny, before the separation of the two great groups of Quadrupeds.

Another instance of isomorphs occurs in the two parallel groups of the *Irideæ* and the *Liliaceæ*. Every one knows how closely similar in outward appearance are the purple crocus of the spring and the purple colchicum of the autumn; and yet the crocus is more nearly related to the yellow iris than to the colchicum; and the colchicum is more akin to the garlic or the Butchers' broom than to the crocus.

It seems as if when two lines of development started from a common point, they sometimes carried *in gremio* the necessity of development along the same lines, and the production of like form at corresponding points in the divergent courses.

FAIRY RINGS.

By A. B. STEELE.

THE green circles, or parts of circles, in pastures, popularly known as fairy rings, have given rise to many curious beliefs and sayings, and their marvellously rapid growth has struck the uncultivated as a supernatural phenomenon. The prevalent belief was that they were caused by the midnight dancing and revelry of the fairies; and Shakespeare speaks of the elves—

> "Whose pastime
> Is to make midnight mushrooms."

In the west of England these rings are called "hag's tracks." In the myths and folk-lore of Sweden they are said to be enchanted circles made by fairies. The elves perform their midnight *stimm*, or dance, and the grass produced after the dancing is called *ailfexing*. A belief prevails in some parts of this country that anyone treading within the magic circles either loses consciousness, or cannot retrace his steps. Many absurd theories have been propounded as to the cause of these rings. Aubrey, who wrote the "Natural History of Wiltshire," in the seventeenth century, says that they are generated from the breaking out of a fertile subterraneous vapour, which comes from a kind of conical concave, and endeavours to get out at a narrow passage at the top, which forces it to make another cone, inversely situated to the other, the top of which is the green circle. Another remarkable theory by a writer, quoted in Captain Brown's notes to White's "Selborne," attributes these rings to the droppings of starlings, which, when in large flights, frequently alight on the ground in circles, and are sometimes known to sit a considerable time in these annular congregations. It was also thought that such circles were caused by the effects of electricity, and for this belief the withered part of the grass within the circles may have given foundation. Priestley was a strong advocate of the electric theory, and was supported by many eminent men of his time.

> "So from the clouds the playful lightning wings,
> Rives the firm oak, or prints the fairy rings,"

says Dr. Darwin, and appends a note that flashes of lightning, attracted by the moister part of grassy plains, are the actual cause of fairy rings. Archæologists suggested that they might be the remains of circles formed by the ancient inhabitants of Britain, in the celebration of their sports, or the worship of their deities. Naturalists formerly came to the conclusion that the rings were caused by the underground workings of insects, and a few years ago a writer in the "Transactions of the Woolhope Club" attempted to prove that they were the work of moles.

These so-called fairy rings, which have long puzzled philosophers, are caused by a peculiar mode of the growth of certain species of fungi, the peculiarity being their tendency to assume a circular form. A patch of spawn arising from a single seed, or a collection of seeds, spreads centrifugally in every direction and forms a common felt from which the fruit rises at its extreme edge; the soil in the inner part of the disc is exhausted, and the spawn dies or becomes effete there while it spreads all round in an outward direction and produces another crop, whose spawn spreads again. The circle is thus continually enlarged and extends indefinitely until some cause intervenes to destroy it. This mode of growth is far more common than is supposed, and may be constantly seen in our woods, where the spawn can spread only in the soil or among the leaves and decaying fragments which cover it. In the fields this tendency is illustrated by the formation of circles or parts of circles of vigorous dark green grass. To get at the cause, however, of the rank growth of the grass composing these rings, is not without its difficulties still. It is known that fungi exhaust the soil of plant-food and store it up in their own substance. In the case of these fairy rings they take up from the soil organic nitrogen which is not available to the grasses, and in some way become the medium of the supply of the soil-nitrogen to the grasses forming the circle. How exactly the nitrogen, one of the most important plant-foods, is fixed by these fungi, has

not yet been discovered; but the grasses immediately following the fungi have been analysed and found to contain a larger proportion of nitrogen than the herbage in the neighbourhood.

Fairy rings are sometimes distinctly visible on a hillside from a considerable distance, many of them being years old and of enormous dimensions. One recorded from Stebbing, in Essex, measured 120 feet across, the grass all over it being very coarse and dark green in colour, chiefly of the cock's-foot species. Rings found in pasture lands are composed of several species of fungi, all of which are edible. They are most frequently observed to be formed by *marasmuis oreades*, a little buff mushroom which most people know under the name of champignons or Scotch bonnets. It is abundant everywhere. For several months in the year it comes up in successive crops in great profusion after rain, and continually traces fairy rings among the grass.

Another and very delicious mushroom, *agaricus prănŭlŭs*, sometimes called the plum agaric, and known in America as the French mushroom, occasionally succeeds a crop of champignons which had recently occupied the same site. It is sometimes found throughout the summer, but autumn is the time to look for it. The only other good edible fungi to be found in any quantity forming rings are the horse-mushroom, the giant mushroom, and St. George's mushroom. The first two are excellent eating, and to be had in the late summer and autumn; but the last are reproduced in rings in spring every year—the circle continuing to increase till it breaks up into irregular lines. The continuity of the circle is a sign to the collector that there will be a plentiful harvest next spring, while the breaking up is conclusive proof that it is going to disappear from that place. Spring is the only time it makes its appearance and the proper place to look for it is the borders of woodlands. It is one of the most savoury of mushrooms, and difficult to be confounded with any other, as it appears at a time when scarcely any other kinds occur. Like the champignon it has an advantage over the common mushroom in the readiness with which it dries, and is largely employed in the preparation of ketchup. It is called St. George's mushroom on account of its appearing about St. George's Day, the 23rd of April, and among the peasants of Austria is looked on as a special gift from that Saint. In Italy a basket of early specimens is a favourite present among all classes.

BEN NEVIS AND ITS OBSERVATORY.—I.

By WILLIAM S. BRUCE, F.R.S.G.S., *formerly in charge of the Observatory.*

(Illustrated by photographs taken by the Author.)

BEN NEVIS, the highest mountain in the British Isles, along with the northern Carn Dearg, forms an irregular semilunar-shaped mass, the concavity of which faces the north-east, and the convexity the south-west. The lower north-western half of this mass is the Carn Dearg, and the loftier south-eastern half, Ben Nevis. Ben Nevis itself, rising in the south as a rather steep slope from Glen Nevis, drops perpendicularly towards the north as a precipice varying in height from one thousand five hundred to two thousand feet. To the west it continues as the north-westerly lying Carn Dearg; to the east it runs into a north-easterly ridge which unites it to the Carn Mhor Dearg.

The summit of the mountain is an elongated plateau, more than one mile in length, averaging about seventy yards in width, and is nearly eleven acres in extent. The Ordnance Cairn lies almost exactly half-way between the two extremities; the Observatory rests close to, and to the south of the Cairn. The broader and more regular portion of this plateau, to the east of the Observatory, may be termed *East End;* the portion divided into three parts by two great gullies, *West End*. These two gullies are known as the *First Gorge* and *Second Gorge* from their respective proximities to the Observatory. Passing from the Observatory to the First Gorge, we find a small building situated on the southern edge of this plateau. Here, during the summer months, visitors to the summit are supplied with refreshments at a moderate cost by some enterprising Fort William purveyors.

Just beyond the southern edge of the summit, lying to the south-south-east of the Observatory, flows a small spring, Wragge's Well, sixty-six feet below the Ordnance Cairn. During a rainless season this spring runs dry, since it is fed solely by rain falling or snow melting upon the summit. Excepting this small spring, where a tank holding a hundred and fifty gallons of water was placed in 1896, there is no other water until, travelling westward, we reach Buchan's Well, at an elevation of three thousand six hundred feet, and even its supply is scanty. Lower down, at three thousand three hundred and fifty feet, is the Chrystal Well, also scantily supplied. The Red Burn has a fair supply of water at two thousand three hundred feet. Below the contour of two thousand feet, nearly two miles from the Observatory, is a fairly large lake. Small streams flow from the south-west side into the Nevis, and at the base of the great northern cliff is a burn containing a considerable volume of water at two thousand five hundred feet. We may safely say that there is no substantial amount of water above two thousand five hundred feet.

Ben Nevis rises as a pink granite mass through the Dalradian crystalline schists. In the centre of this granite is a plug of dark porphyry. For the lower three thousand feet or so of the ascent one traverses this pink granite, the higher portions of which are more finely grained than the lower. After the granite comes the dark porphyry, of which about the last thousand feet of the mountain is entirely composed.

The ordinary unobservant individual would say that the last two thousand feet of the Ben was devoid of vegetation; but, on examination it is found that there is scarcely a rock which is not more or less covered with one or more species of lichens, whilst there are also numerous mosses growing wherever there is a suitable nidus. This is true, even on the summit plateau, where the disjointed masses of porphyry, with their strangely brecciated surfaces, form so striking a feature. In some places round the edges of the cliff these mosses grow quite luxuriantly, as well as one or two phanerogams.

As in the case of vegetation, so it is in that of animal life the ordinary visitor would not note much. Yet, in fine weather, the mountain top is swarming with insects. There are spiders and snow-fleas, coleoptera, diptera, hymenoptera, and many others, etc. Snow buntings and ravens are there for nearly the whole year; now and again ptarmigan or a golden eagle may be seen. Curiously enough, voles have been captured on the summit, even in midwinter, about the Observatory, and foxes, stoats, and mountain hares are not unfrequently seen.

The first question most people ask when they reach the summit of Ben Nevis during the summer months is:—Why do you take observations on the top of a mountain, and

what is the use of such observations? Let us regard our atmosphere as an ocean, only, instead of being an ocean of water, four or five miles deep, let us remember that it is an ocean of air manifold deeper—that it is, in fact, an "atmosphere," instead of a "hydrosphere." Like star-fish, sea-spiders, and other deep sea denizens, we creep about at the bottom of this ocean of air and know little or nothing about the conditions which exist in the upper atmosphere. And it is our true scientific instinct that leads us to sound, as it were, upwards, and to explore into the upper reaches of the atmosphere just as we sound downwards and explore at the bottom of the sea. There are various ways of doing this: we can study, for instance, the height of clouds, their speed, direction and constitution, and learn a good deal regarding temperature, winds, and so forth. This can be done by careful eye observation from below, but how much more satisfactorily can it be done if we actually ascend into those upper strata of the air by a balloon, or by climbing to the top of mountains, which rise up like islands from the lower into the upper atmosphere!

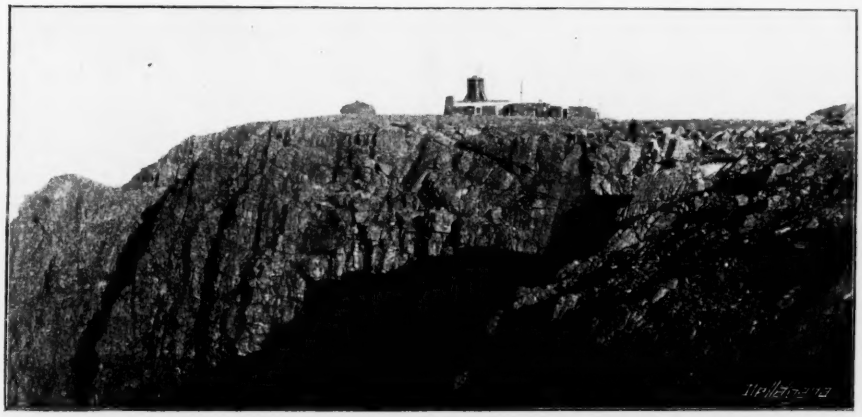

FIG. 1.—Ordnance Cairn and Observatory on the Summit of Ben Nevis showing the Great Cliff: Summer.

In 1875, Mr. Thomas Stevenson proposed to establish from the top to the bottom of some mountain a series of stations, in order to find out what was occurring in the atmosphere at different levels. It was pointed out that Ben Nevis, of all places, was most suitable.

First.—Because it was the highest mountain in the British Isles, rising to four thousand four hundred and six feet.

Secondly. — Because its summit was in close horizontal proximity to a sea-level station at Fort William.

Thirdly.—Because it was situated in the track of the south-west storms, which influence so greatly the weather of Europe, especially in autumn and winter.

It was urged that these observations would have important bearing in forecasting storms; for, unlike the Americans, who can track the course a storm is taking across their continent by means of their meteorological stations, we are unable to do so on account of the wide extent of the Atlantic Ocean, where we can have no permanent stations with telegraphic communication. Indeed, it is hardly possible to foretell that a storm leaving the American coast will reach our shores.

To Mr. Clement Wragge, now Government Meteorologist to Queensland, we owe the first actual series of observations. From June till October, 1881, without the break of a single day, he climbed the Ben, and took observations on the summit, while Mrs. Wragge took synchronous observations at Fort William. He made similar observations on an extended scale with two assistants during 1882; and during 1883 similar observations were carried on by Messrs. Whyte and Rankin, who had previously assisted Mr. Wragge. On account of the high importance of these observations, which were so ably discussed by Dr. Buchan, an appeal was made to the public for funds, and under the auspices of the Scottish Meteorological Society, four thousand pounds were soon collected in amounts varying from two hundred pounds to a penny; every class was represented, from Her Majesty downwards.

On the 17th October, 1883, Mrs. Cameron Campbell, who granted the site, opened the Observatory on an ordinary Ben Nevis winter day, amidst wind and driving snow. At the same time Mr. C. Livingstone started observations at the public school at Fort William.

It was intended to take twenty-four hourly observations during the day, reading the barometer and thermometers, and making notes of wind, cloud, rainfall, and so on. But before two or three feet of snow were covering the summit, great drifts were piled up round the building, and as no arrangement for keeping the doorway clear had been made, constant digging was required. As long as the weather was fine this was easily accomplished, but when the wind rose

FIG. 2.—Observatory from South: Summer.

the snow drifted in much faster than it could be dug out, and it had to be left to drift up. All observations were stopped for some hours until it had again become calm. Then two or three hours' spade drill would clear the passage through the snow. "This," writes Mr. Omond, "was good exercise, no doubt, but a kind of work not usually included in the routine of an observatory." When the snow reached its winter depth of ten or twelve feet, the work became stupendous, and even as late as May, 1884, the continuity of outside observations was broken from this cause. By next winter the building had been added to and improved, by having an office and a tower erected. The result was the lessening of the labour of observations. There is now a door at the top of the tower by which exit can be made at any time during the whole winter.

Since then—that is, for nearly sixteen years—hourly observations have been taken without a break, except on one or two occasions, when, for a few hours, wind and snow-drift rendered it impossible to stand or see the thermometers outside. Any ordinary gale can be faced if the observer is protected by oilskins and keeps his lantern to leeward, but sometimes the wind rises above one hundred miles an hour, carrying with it drift and solid pieces of ice ripped off the snow surface, which are sufficient to break the plate glass windows of the Observatory if the latter do not happen to be buried beneath the snow. I do not wish you to imagine that you always have gales of this description blowing; it is an occurrence, perhaps, once or twice a year, although gales of not so violent a character are not infrequent. But now there is no need to break the continuity of temperature observations, since a special louvred screen has been devised to be read from within the Observatory tower. And this, even when the wind is blowing with great force, is very fairly correct.

"The whole building is of a most substantial character. It is all on one story, except the tower, and consists of double wooden walls covered with felt and surrounded by dry stone walls, varying in thickness from four feet, in the less exposed parts, to ten feet at the base of the tower; the windows are all double and the roof is covered with lead overlaid with snow boarding. The strength of the whole has been frequently tested by gales of a severity and duration never experienced at lower levels."

(*To be continued.*)

SOME SUSPECTED VARIABLE STARS.—II.

By J. E. GORE, F.R.A.S.

ι ANDROMEDÆ.—This star was rated a bright 4th magnitude by Sufi, 4 and 5 by Lalande, 6 by Harding, 4 by Argelander and Heis, 7 by Piazzi, and 3-4 and 7 by d'Agelet. It was measured 4·56 at Oxford and 4·30 at Harvard. My own observations, 1875-1884, show well-marked fluctuations in its light to the extent of about half a magnitude. It is sometimes distinctly brighter than its neighbour κ Andromedæ, and sometimes quite as distinctly fainter. The observations, however, do not seem to show any regular period.

ε Pegasi.—This star, which is usually rated about 2½ magnitude, was found by Schmidt unusually faint in a perfectly clear sky on November 5th, 1847. Signs of variation were also found at Cordoba. Seidel from photometric determinations believed it to be variable, and Schwab's observations indicate a variation with a period of about twenty-six days.

83 Ursæ Majoris.—This star, which lies near ζ Ursæ (in the Plough), was seen by Birmingham as bright as δ Ursæ in August 1868. Birmingham says: "This star, which is ordinarily of the 6th magnitude, I saw as large as δ Ursæ, between 3 and 4 magnitudes, on August 6th, 1868. It was smaller on the next night, and slowly diminished to its usual magnitude." It was rated 6-5 by Argelander, and 5-6 by Heis, and was measured 5·10 at Oxford, and 4·83 at Harvard. On January 28th, 1878, I found it brighter than Alcor (the naked eye companion to ζ), but on February 7th, 1884, it was distinctly fainter than the same star.

z Virginis.—This star, which lies about two degrees south of Spica (α Virginis), and is usually about the 6th magnitude, was seen by Schmidt between the 4th and 5th magnitude on June 6th, 1866. It was then considerably brighter than 68 (i) Virginis, which lies between it and Spica. It gradually diminished in brightness, but even on June 19th it was still visible to the naked eye in moonlight. Schjellerup, in his translation of Al-Sufi's "Description of the Heavens," identifies the star with one marked 19 of Virgo, by Sufi, and thus described by the Persian astronomer, "La 19 est la méridionale du côté postérieure du quadrilatère, après *al-simak* (Spica) s'inclinant vers le sud; elle est des moindres de la cinquième grandeur; Ptolemée la dit absolument de cinquième, mais elle est plus près de la sixieme. . . . Avec *al-simak* et la 17me. (76 Virginis) elle forme un triangle isoscèle, cette étoile etant au sommet." From this description it is absolutely certain that Sufi's star is identical with the one seen by Schmidt. Observations at Cordoba, 1871-78, vary from 5·7 to 6·3 magnitude, and the star would seem to be certainly variable, although it has not yet been admitted into the list of known variables. In 1879, Burnham discovered that the star was a very close double, the components being 6·2 and 6·5, and separated by less than half a second of arc.

65 Ophiuchi.—This star is supposed to have disappeared, as it was duly observed by Flamsteed on May 6th, 1891, and the observation was regularly reduced by him. No such star is now to be found in the sky. It was looked for at Greenwich, but without success. There is no star in Flamsteed's position in Argelander's southern zones, or in the Washington zones, nor is it in Lalande's Catalogue or Harding's Atlas. It has been suggested that Flamsteed may possibly have observed a so-called "new" or "temporary star."

37 Leonis Minoris.—Smyth (in his "Celestial Cycle") says that Piazzi called this star "by its old name Præcipua, as the *lucida*, or principal star of Leo Minor, registered of the 3rd magnitude by Hevelius and continued so by Bode. Mr. Bailey, however, in his recent edition of Flamsteed has rated it 5¼ in lustre under the following plea. "This star," he says, "is marked as of the 3rd magnitude in the British Catalogue, but in the *original* entries it is designated three times as of the 6th, once of the 4th, and once as 4½, but nowhere greater. I have taken the mean of the whole." Schmidt adds, "I have never seen it but as given above from Piazzi" (4th magnitude). It was rated 5-4 by Argelander and Heis, and was measured 4·87 at Oxford, 4·76 at Harvard, and 4·90 at Potsdam.* On April 29th, 1886, I estimated it two steps less than 31 (β).

ζ Piscis Australis.—This star was rated 5th magnitude by Ptolemy, 5-6 by Sufi, 6 by Ulugh Beigh, 6½ by Lalande, 6 by Lacaille and Harding, 6-5 by Behrmann, and 5-6 by Argelander and Heis. Gould found it 6·6, or 6·7 from observations at Cordoba. It was measured 6·62 at Harvard.

* The standard star, Polaris, is in the Oxford photometry 2·05, in the Harvard 2·15, and in the Potsdam photometry 2·34.

From a consideration of the various recorded magnitudes, C. H. F. Peters came to the conclusion that the star is probably variable with a long period. The fact of its having been seen at all by Sufi proves beyond reasonable doubt that it must have been brighter then than it is at present. I estimated it about 7th magnitude in August, 1877, and November, 1882.

η Crateris.—This star was rated 4-3 by Ptolemy, 5-6 by Sufi, 4 by Ulugh Beigh, Tycho Brahé, and Hevelius, 6 by Argelander and Heis, 5·4 by Gould, and only 6·7 by Houzeau. It was measured 5·01 at Harvard. The star seems certainly variable to a considerable extent, but the period may be very long; otherwise, it seems impossible to explain how a star which was seen only $6\frac{1}{3}$ magnitude by Houzeau—or barely visible to the naked eye—should have been rated fourth magnitude by Tycho Brahe, who was a very accurate observer.

"The Story of θ Eridani" has been already told in a most interesting paper in KNOWLEDGE (July, 1893) by Dr. Anderson, the discoverer of Nova Aurigæ. I fully agree with Dr. Anderson that θ Eridani is certainly identical with the "Last in the River" of Ptolemy, and the Achernar of Sufi, and that consequently the star has undoubtedly faded from the first magnitude to about the third since the tenth century. It is one of Sufi's thirteen first magnitude stars, and his clear description of its position places its identity beyond all doubt. In recent years the star has been suspected of variation in its light. It is a splendid double star—one of the finest in the heavens.

We will now consider some telescopic objects. The famous variable star Algol has several faint companions. One of these was discovered in 1787 by Schroter, who strongly suspected it to be variable. Sadler thought it variable from 10th to 14th magnitude in some short period. A writer in *Nature* (February 20th, 1879) stated that he failed to see any trace of the star on several fine nights in the early part of 1874, using a seven-inch refractor, but on September 9th of the same year he saw the companion very distinctly with the same instrument. It was measured by Talmage at the Leyton Observatory on October 2nd, 1874, and estimated 11-12; and in 1878 by Burnham, who found three other fainter companions, one not far from Schroter's companion and forming with it a wide double star. Franks found it "easy enough" with an eleven and a-quarter inch reflector on January 11th, 1885, and about two magnitudes brighter than Burnham's faint companion. If variability is confirmed it will be very interesting, as a variable companion to a known variable star would be a rather unique object. There is, however, a somewhat similar case in the star S (15) Monocerotis, which is supposed to be a short period variable. A distant companion to this star was rated $8\frac{1}{2}$ magnitude by Main in 1863, but only 12 magnitude by Sadler in 1875. Observations by Mr. Tarrant in March and April, 1888, showed a variation of $1\frac{1}{2}$ magnitude in about three weeks. On March 28th, 1889, observing with a three-inch refractor, I found the suspected variable about one magnitude brighter than another companion a little to the west of it.

ζ Ursæ Majoris.—In *Comptes Rendus*, Vol. XIII., p. 438, Mädler states that he found the companion to this bright star invisible on April 18th, 1841. About an hour afterwards it was again visible, and he suggests that the companion is variable "comme Algol, mais probablement avec une période beaucoup plus longue." His account leaves it uncertain whether Alcor or the closer companion is referred to, but as he seems to have been using a telescope at the time, probably the close companion is meant. The naked eye companion Alcor has also been suspected of variation in brightness.

γ Virginis.—The components of this famous binary star were considered by Struve to be alternately variable in brightness. His observations in the years 1851 and 1852 show that sometimes the component stars were exactly equal in brilliancy, and that sometimes the Southern star—the one generally taken as the primary star—was from 0·2 to 0·7 magnitude brighter than the other. There seems to be little doubt that some variation really takes place in the relative brightness of the pair. This is clearly shown by the measures of position angle. For example, in the year 1886, Prof. Hall recorded the position angle as 154·9°, evidently measuring from the Northern Star as the brighter of the pair; while in 1887, Schiaparelli gives 334·2°, indicating that he considered the Southern Star as the primary or brighter of the two. Burnham found 153·4° in 1889, and Dr. See 332·50° in 1891. The period of variation would seem to be short, for O. Struve found the Southern Star half a magnitude brighter than the other on April 3rd, 1852, while on April 29th of the same year he found them "perfectly equal." He thought the variation was about 0·7 of a magnitude, but that the climate of Poulkova, where he observed, was not good enough for such observations. The variation is very interesting, and the question should be thoroughly investigated with a good telescope.

Pollux (β Geminorum).—Admiral Smyth measured two faint and distant companions to this bright star, and says (Bedford Catalogue, p. 187): "A, 2, orange tinge; B, $12\frac{1}{2}$, ash-coloured; C, $11\frac{1}{2}$, pale violet; and it has a minute *comes* to the *s. p.*, which, though unnoticed in former registers, is certainly now (1832) as bright as C; these companions form a neat triangle." And he adds in a foot-note: "While this is in the press, the Rev. W. R. Dawes has shown me an exact diagram which he made of the object, January 1st, 1829, with a three and a-half foot achromatic, charged with a Huygenian eyepiece magnifying two hundred times. With this instrument he saw the three companions very distinctly, although two only were visible, and that but on remarkably fine nights, in Sir James South's seven foot equatorial, with an aperture of five inches." In the *Monthly Notices*, R. A. S., for April, 1861, the Rev. T. W. Webb says that with his five and a-half inch object glass the third star appears "as much inferior to B, 12m., as B is below C; and as Sir James South's equatorial of five inches had shown but two companions some years before the date of the Bedford Catalogue, there is, perhaps, grounds to suspect a variation in its light." Burnham, in 1879, rated Smyth's star C as 9th magnitude, and the third star $9\frac{1}{2}$. In 1878 he called B 10th magnitude. On January 30, 1880, observing Pollux with a three-inch refractor and power one hundred and thirty-three, I found C quite plain and B tolerably so, with Pollux in the field of view; D, Smyth's third star, only seen with Pollux just out of the field; C about one magnitude brighter than B, and B one a-half or two magnitudes brighter than D, which was very faint. To my eye C seemed about 10th magnitude (Smyth's scale), B 11th magnitude, and D about $12\frac{1}{2}$. On March 31st, 1881, I again examined the star with the same instrument and power, and found C brighter than B, and D very faint, hardly visible. D was not visible with a power of eighty-three. If D was ever equal to C, as expressly stated by Admiral Smyth, it must certainly be variable.

There are many other telescopic objects which have been suspected of variable light, and some of these I may deal with in a future paper.

XUM

CLOUDS.

By E. M. ANTONIADI, F.R.A.S., and G. MATHIEU,
of the National Agronomical Institute, Paris.

THE application of photography to the study of meteorological phenomena enables us to investigate with great advantage the form and height of the various clouds, the appearance of water-spouts, rainbows, halos, coronæ, etc., as well as to record the fugitive sinuosities of the lightning flash.

Nor does this mode of enquiry require any modification of the camera. A good large-angle object-glass with an ordinary shutter is all that is needed. For clouds, however, floating about the zenith a moveable-headed foot will be found of use.

The simultaneous photography of the same cloud from two different stations will give its height above the earth's surface. At his private observatory of Trappes (Seine-et-Oise), M. Léon Teisserenc de Bort utilizes for this purpose two photographic theodolites of the type adopted by Her Majesty's Government in India. The instruments are separated by a distance of one thousand three hundred and eighteen mètres, while they are united by a telephone, destined to ensure the simultaneity of the operations. In this way, M. de Bort has secured results of permanent value.

FIG. 1.—"Mare's Tail" Cloud, 6d. 2h. 25m. local time, photographed on 1899, May.

If we look at the sky through a spectroscope, we see all

FIG. 2.—"Mackerel Sky," 1898, September, 21d. 4h. 51m.

the colours of the spectrum, though blue is the predominant colour; but it is only the reflected light that is blue, the transmitted light is orange or red. The action, therefore, of the particles of our atmosphere on sunlight is apparently dichroitic. A careful consideration of these phenomena led the late Prof. Tyndall to the statement that our gaseous envelope behaves exactly as if it were laden with extremely small particles, impinged upon by the minute waves of ether. And, as "in the case of water, for example, a pebble will intercept and reflect a larger fractional part of a ripple than of a larger wave," similarly the small particles of the air would exert their most conspicuous action upon the smaller waves, a predominance of blue in the scattered light being the consequence. By his classical experiments on "actinic clouds," Prof. Tyndall brought to light * the brotherhood existing between the blue colour and polarization of skylight and the phenomena observed on exceedingly fine precipitates. But the sifting action exerted by these particles on the constituents of white light being solely a product of their exiguity, an increase in the diameter of the particles must necessarily entail a whitening of the diffused light; and as the dimensions of these bodies vary inversely as their height above the earth's surface, the sky ought to appear, and actually *does* appear, whiter near the horizon than about the zenith.

Thus much with the blue reflected light. The red hue of the transmitted light is accounted for, in this theory, by the assumption that "through its successive collisions with the particles, the white light is more and more robbed of its blue constituents."

The predominance of violet rays in the reflected skylight is, in the large majority of cases, a perpetual drawback in cloud photography, since the photographic action of blue light is almost identical with that of white light. Hence the necessity of devising some means to quench the violet of the sky, while preserving the light of the clouds. To this end various methods have been devised.

Prof. Riggenbach has utilized the polarization of skylight. The maximum of polarization being observable at

* "Fragments of Science," Vol. I., Chapters on "Artificial Sky" and "The Sky."

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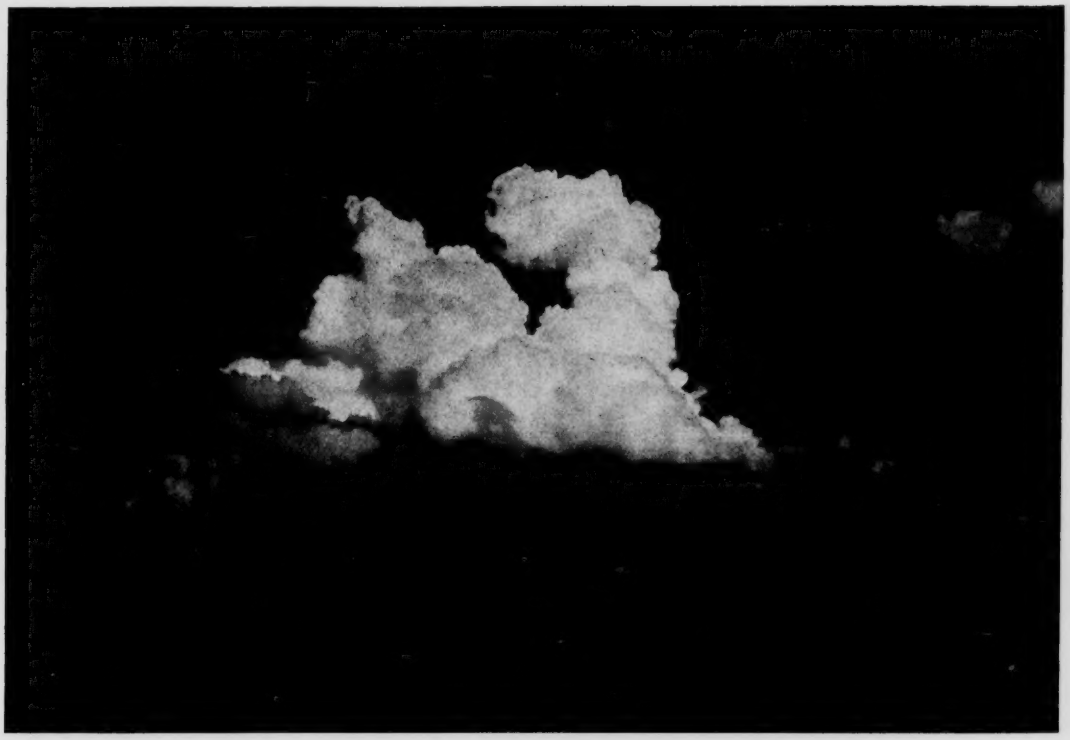

FIG. 1.—Large Thunder-Storm Cumulus, photographed on 1898, August, 23d. 1h. 20m.

FIG. 2.—Light Cirro-Cumulus in the Upper Regions, with Stratus in the Foreground. 1897, September, 16d. 4h.

PHOTOGRAPHS OF CLOUDS.

XUM

an angle of ninety degrees from the sun, if the heavens are scrutinized in the proper direction through an analyzer (Nicol or black mirror), a large proportion of the rays emitted by the blue of the sky will be quenched, while the intensity

FIG. 3.—Stratus, 1898, November, 2d. 4h. 15m.

of the clouds will not be very considerably attenuated. This enhances contrast, and gives fine views.

Another method of the same physicist's consists in simply photographing the sky with a small diaphragm and short exposure. This gives next to nothing after development; but an energetic intensification of the negative with bichloride of mercury and sulpho-antimoniate of soda, seems to give fair results.

The most practical way, however, of quenching the blue of the sky is that of placing in front of the objective a yellow glass or solution contained in a cell with parallel sides. This is the method adopted, after many trials, by MM. Hildebrandson, Angot, and Teisserenc de Bort, and, invariably, by the present writers.

Exposures in cloud photography are usually very short. According to M. Angot, of the Bureau Central Météorologique, who is a past master on the subject, a long exposure is usually preferable to a short one, because, after development and fixing, it is easy to give a long-exposed negative the necessary intensity by dipping it in hyposulphite of soda dissolved in water at ten per cent., to which should be added a solution saturated with red prussiate of potash. The action of this liquid on the image is a reducing one, by which the intensity of the negative is diminished. A prolonged washing ought to follow. By this means M. Angot drew excellent results from over-exposed plates, while the intensification of under-exposed ones gave him only bad negatives.

Having undertaken at Juvisy, at M. Camille Flammarion's suggestion, and under his superintendence, a continued photographic study of the optical phenomena of our atmosphere in general, and of the various forms of clouds in particular, the writers thought it might interest the readers of KNOWLEDGE to give them a brief account of the work done here in this line since the summer of 1897.

The apparatus used is an ordinary seven-inch by five-inch camera, to which can be adapted either an "orthoperiscopic" object-glass by Derogy, 1·42-inch aperture, or a smaller glass by Lévy, 1·01-inch only, but giving a wider field of view. Various coloured screens have been utilized here: (*a*) a yellow glass; (*b*) yellow gelatine; and (*c*) a solution of bichromate of potash contained in a cell with rigorously parallel sides. It is not difficult to make yellow glasses. Fixing with hyposulphite of soda a thin, unexposed, photographic plate, and then dipping it into chrysoidine dissolved in water, the film will be tinted with the most exquisite yellow. The intensity of the colouring will, of course, entirely depend on the quantity of chrysoidine used.

Convenient as the interposition of a mere coloured glass is, the use of a yellow solution in a glass cell has been found more advantageous. The varying intensity of clouds requires different shades of yellow. Thus, very light cirri on a milky sky will not print their delicate filaments on the plate without a *strong yellow* screen, while a bright cumulus, projected on a dark blue sky, might be advantageously photographed through a very light yellow only.

But, however efficient the coloured screen, contrast will be rendered still more prominent by the use of isochromatic plates. The panchromatic plates of Messrs. A. Lumière et ses Fils, of Lyons, have been invariably used by the present writers.

The photographs accompanying this paper exhibit the chief forms of clouds, by giving Luke Howard's three primary types and their compounds.

A cirrus of the "feather" or "spray" type is shown in

FIG. 4.—Small Cumuli during fine summer weather, 19d. 1h. 5m., 1898, September.

Fig. 1. A glance bestowed on this photograph will give an idea of the action of the yellow screen; the cloud was so delicate to the naked eye, that its ramifications could barely be discerned from the bright bluish-white background of the sky, and yet its slightest filaments can be detected on the negative, where the contrast with the sky is most marked. The cirrus in question was the first

cloud of the day, coming after a spell of very fine weather. Borne by a north-easterly wind, it was gradually drifting

FIG. 5.—Rain-Clouds, 1898, May, 12d. 3h. 30m.

to the south-west. Other cirri then followed, while a few cumuli put in an appearance towards four o'clock in the afternoon. The sky became finally overcast, and 0·13 in. of rain fell on the morrow.

In Fig. 1 of the accompanying Plate we have a fine cirro-cumulus texture, with clouds at the lower level (stratus) crossing the sun, as if "brushed up" from the south-west.

A coarser cirro-cumulus is shown in Fig. 2. Here we note heavier cumuliform masses, bordering on what is termed *Alto-Cumulus* on the Continent. In the upper part of the photograph, the small clouds are separated along curious, definite, and nearly parallel straight lines. The formation of these cirro-cumuli was preceded and followed by fine weather, though it coincided with a slight barometric depression.

Fig. 3 is a view of a bank of stratus above the valley of the Seine, east of Juvisy. These clouds had given rise to foggy, overcast weather a few days previously. On the

FIG. 6.—Scud drifting before a grey sheet of Cirro-Stratus, 1898, July, 19d. 3h. 50m.

photograph, contrast is deficient, and the outlines are vague. But Mr. Scott, of the Meteorological Office, says that stratus cloud is "not in any way consolidated into a definite form."*

The cumuli of Fig. 4 are of those peaceful little clouds, following, accompanying, and forecasting fine, warm, summer weather. The perspective grouping of the clouds near the horizon, to the right, shows an appearance of *Roll-Cumulus*, while the upper cloud, passing in the vicinity of the sun, shows a dark body with golden fringes.

One is struck by the flatness of the base of the cumulus. Such horizontality is due to the fact that the base marks the height above the earth's surface, at which the ascending vapours, chilled by expansion, reach the dew-point. Another interesting feature about cumuli is their remarkable appearance of solidity:—"The hills and white valleys at our feet," says M. Flammarion, in one of his balloon ascents, "appear so solid as to invite us to leave the car and step on them. What a surprise, were we to yield to this temptation!"

But cumuli do not always assume this serene, benignant appearance. They easily swell into menacing mountains, with silvery

FIG. 7.—A Photograph of the Rainbow, taken at Juvisy after a violent storm, on 1898, June, 2d. 5h. 20m. local time.

white crests, and sombre, thundering bases. This is particularly the case during a thunderstorm (Fig. 1 of the accompanying Plate), where the proud masses, scaffolded by an uninterrupted supply of vapour from below, roll confusedly over each other, heaping themselves into pyramidal figures of fantastic appearance.

The nimbus of Fig. 5 was taken during a showery day of the spring of 1898. Rain is falling on the horizon, towards the right-hand side of the picture. It should be remembered that it is to the successive reflections and consequent exhaustion of the light falling on the water droplets that rain-clouds owe their darkness, and that the light is scarcely quenched here by true absorption.

"Light scud-clouds driving across heavy masses," says Admiral Fitzroy, "show wind and rain." Such are the small clouds of Fig. 6, drifting in the foreground of

* "Instructions in the Use of Meteorological Instruments," 1888, p. 67.

a dull cirro-stratus cloak (M. Poey's *Pallium*) during a storm.

On the 2nd of June, 1898, the writers were enabled to secure the photograph of the rainbow shown in Fig. 7. Exposure = $\frac{1}{10}$ second. Diaphragm on the Derogy objective = $\frac{f}{18}$. It will be seen that the bow produced on the negative the effect of a luminous arch projected on darker background. It was obviously the shorter waves which proved the most efficient in the impression of the meteor. The bow can be traced in the reproduction down to the landscape, especially in front of a row of poplar trees bordering the right bank of the Seine. The altitude of the sun at the moment being some twenty-one degrees, the top of the arch was raised some twenty degrees only above the horizon.

The photograph is interesting as showing the inner space of the bow to be much brighter than the outer, an appearance which is not always noticeable to the eye. This is due to the fact that whereas no light is sent to the observer from the back of the drops situated outside the first, and as far as the secondary bow, the drops inside the primary do reflect light from their back, which in spite of its enfeeblement through divergence, suffices to vaguely illumine the inner segment. This is the region of the "supernumerary bows" unexplained by Descartes and Newton, but to which the illustrious Thomas Young, with the intuition of genius, applied his discovery of the law of interference of light. The condition necessary for the appearance of the supernumeraries is that the drops shall all be of nearly equal sizes. Otherwise, as in the case of the photograph, we have a confused superposition of the various colours, which are thus blended into white light.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

THE RESOURCES OF THE SEA.

To the Editors of KNOWLEDGE.

SIRS,—I notice in your issue of July 1st a somewhat guarded review of Prof. McIntosh's new work on "The Resources of the Sea."

The points at issue between the author and the Scottish Fishery Board are, though interesting in themselves, of minor importance compared with the opinion freely expressed in several places throughout the work, namely that no restrictions should be placed on any method employed or any area of our sea fisheries. Thus, at p. 228, the author says:—

"So little can be done by man in the way of altering Nature's laws in the sea that it might be more prudent to leave the adjustment of the supply and the demand in her hands."

Again, at p. 234, he writes:—

"Yet so far as history and so far as observation at the present time go there is no ground for alarm in regard to the permanence of the food fishes."

The matter is put more specifically on p. 229:—

"The grave and permanent deterioration of our in-shore and off-shore fisheries has been dealt with in the foregoing pages, and by a practical and unbiassed examination of the areas themselves and of the statistics of fishes caught in them, the condition is shown to be one that inspires confidence and not alarm."

Permit me then to point out, Sirs, what those statistics consist of. They are records of certain hauls of the trawl net, by various vessels of greatly varying tonnage, extending over periods varying from ten to two years, made in certain closed areas around the Scotch coast. When practical men are told that in certain tables—"barren hauls are omitted" (p. 104), that trawls with beams varying from ten to fifty feet, with nets of varying mesh were used, and that the trawling was "for the most part carried on by daylight" (p. 105), such statistics will be appreciated at their true value.

But, Sirs, the records of the fish markets and the newspapers are and have proved conclusively that the fishing grounds around our coasts are no longer producing our fish food supply, and are indeed depleted; and, further, that our trawlers are now busy at the same work in Icelandic and Biscayan waters, despite the strenuous opposition of the coast authorities.

The author does not deny this, for, at p. 95, he writes:—

"To commence with the most northerly, viz., Aberdeen, at which trawling has made great progress since the former date (1884), it is found that, whereas the chief supplies were brought fresh from the adjoining sea by the older paddle ships, or from the Moray Firth by the more powerful vessels, much of the supply of the present day comes from the Great Fisher Bank or from Iceland."

Again, speaking of the Government returns, he says:—

"While, therefore, the present statistics show no serious diminution, it may be truly said that the total is kept up only by supplies from Iceland, Faroe, and the Great Fisher Bank."

Surely, Sir, no "scientific observer" such as described on p. 223, of whom it is said "the welfare of the fisheries as a whole is his aim," can look on, while Hewitt's Short Blue Fleet is shut down because the North Sea grounds no longer yield a profit, and the British steam trawler is daily seized and fined for fishing in Danish territorial waters, without drawing some practical conclusion therefrom. Men do not abandon large and old established businesses, or run the risk of getting hundreds of pounds worth of goods confiscated without some reason; and that reason is plain to the intellect of even the unscientific, namely, that the fish in the old fishing areas are no longer caught profitably. This means to us:—

1. That another food stuff has to be brought from abroad;
2. That thousands of hard-working fisher folk are being ruined;
3. That the fishermen-seamen counted upon by our experts to help man the Navy, are being reduced in numbers by leaps and bounds.

One can only hope that this cleverly written book by one of our highest authorities, with its bald and unconvincing conclusions, will not tend to delay still further the reform of our fisheries until it is too late.

CHARLES S. PATTERSON, M.B., M.R.C.S., F.Z.S.,
Hon. Sec. British Sea Anglers' Society.

THE SUN'S RADIANT HEAT.

To the Editors of KNOWLEDGE.

SIRS,—A point touched on by your reviewer seems to me worth discussing on its own account, and I hope some of your able correspondents will be able to throw light upon it. For my own part I have not adopted any theory on the subject. The question is this, What becomes of the radiant heat of the sun?

According to the ordinary view the sun is constantly radiating heat in all directions, and, I think, it is generally supposed that it is only a small portion of this heat that encounters material bodies at any distance however great. If so, the question arises what becomes of the residue?

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Physical research leads us to believe that heat cannot be destroyed but only transformed; yet many persons seem to think that this heat vanishes like a ghost without transformation and without producing any effect. This may be so, but it is so much opposed to physical analogies that we should be slow to accept it unless on the basis of definite observations which, I think, it will be admitted are not at present forthcoming. Nor can we confine the question to the sun. The loss of radiant heat must (on the theory which I am now considering) extend to all the stars. A larger portion of the heat of some of them is no doubt intercepted by other bodies, but some of it must escape—vanish. The whole universe is losing heat; or at least it is losing motion, for the supply of heat may be temporarily kept up by the conversion of motion into heat (as, for example, by a bombardment of meteorites). But that a good part of the radiant heat vanishes, thus lessening the total amount of force—of heat and its equivalents—in the universe, seems to be a common opinion. This theory, however (for of course everything on the subject is theory), will strike many of your readers as unsatisfactory for physical, not metaphysical or theological, reasons. But if this heat be not lost, what becomes of it?

If the sun's rays and those of the stars always met with some material body, however great its distance might be, the problem would be solved; there would be no loss of heat to the universe. The sun may at present be radiating more than it receives, and, consequently, cooling; but in travelling through space it may reach other regions in which these conditions will be reversed. But it seems plain that if this be the case, the greater part of the bodies which encounter the solar heat are dark bodies, or else that there is an absorption of light in passing through the ether. Such an absorption of light and heat by the ether—as maintained, I believe, by the great observer Struve—would equally solve the problem; for the light and heat thus absorbed could not be lost, and would probably be given back by the ether to material bodies in some manner not yet traced. Otherwise, it would change the properties of the ether.

A third possible alternative is that radiation, like gravitation, only acts between material bodies, and that, though, like gravitation, it acts on a material body in any direction and follows it in all its movements, there is no expenditure of force in the directions in which no material body is encountered. On this theory also there would be no loss of heat. There would only be an interchange of the same kind as if every heat-ray ultimately encountered a material body.

KNOWLEDGE since its foundation by Mr. Proctor has always distinguished itself by its readiness to discuss questions of this kind. Mr. Proctor was indeed more of a theorist than an observer, and his spirit has not died with him; and I trust that the pages of KNOWLEDGE will continue to be open to the theorist as well as to the observer.

W. H. S. MONCK.

DARK RIFTS AND LANES IN NEBULÆ.

To the Editors of KNOWLEDGE.

SIRS,—The dark rifts and lanes which are visible in Dr. Robert's splendid photograph of the Nebula N.G.C. 2237–9 Monocerotis are most remarkable, and, as Colonel Markwick points out in your issue for this month, it is very difficult to explain their cause. The idea that they are holes right through the nebula, so that we are able to see through them the dark space beyond, is open to very serious difficulties. A possible explanation which occurs to me, and which I don't think has yet been suggested, is that the darkness is caused by patches of cool gas being on the outside of the nebula and between us and the incandescent gas beyond. This layer of cool gas would be quite opaque to the light coming from the bright portions of the nebula, and would thus cause a dark patch. The spectrum of the nebulæ is of such a simple kind, consisting of only a few bright lines, that the light coming from a star situated beyond the nebula would shine through one of these dark patches, and the only change in its light would be caused by a few dark lines in its spectrum, which would lie in the same position as the bright ones in the spectra of the nebula. If these dark patches are caused, as I suggest, in this way, it is, I think, possible that they may be more clearly seen in the photographs of nebulæ than when they are examined visually, as the ultra violet end of the spectrum would be more affected by the absorption of the cool layer.

We know yet so very little about the nebulæ, and have so few solid bases to build upon, that I merely offer this as one possible explanation of these curious dark rifts.

W. E. WILSON.

Obituary.

We regret to record the death of Prof. Robert Wilhelm Eberard Bunsen, which took place at Heidelberg on the 16th August. As most students of science know, Bunsen for more than half a century past exerted a profound influence as a preceptor on a large proportion of leading chemists of the day. Born at Göttingen in 1811, after studying in the university of his native place, he amplified his attainments at Paris, Berlin, and Vienna, and then became professor of chemistry in Cassel, Marburg, Breslau and Heidelberg in succession. At the latter place he built a grand laboratory, and made it one of the best schools of its kind in Europe. Among his discoveries are the burner which bears his name, the electric pile, mode of producing magnesium on a large scale, and, in conjunction with Kirchoff, spectrum analysis, which in the hands of chemists has added so much to our knowledge of the elements, and under the control of astro-physicists has given birth to the new astronomy—a branch of practical science opening up new vistas in celestial space and evolving a simple, yet wonderful, means of deciphering the hieroglyphics of the stars. Many lives have been saved by his discovery of hydrated oxide of iron as an antidote to arsenic poisoning. Perhaps the most striking of his contributions to science is that of 1861, when he proved the presence of rubidium and cæsium in a few drops of mineral water from Durkheim by the aid of the spectroscope, and his evaporation of several tons of the water to obtain a sufficient quantity of the new metals to experiment with. Among his chief works are: "On a New Volumetric Method," "A Treatise on Gas Analysis," and "Chemical Analysis by the Spectroscope."

Sir Edward Frankland, a famous pupil of Bunsen, died in Norway on the 10th August. Born at Churchtown in 1825, he was educated at Lancaster Grammar School, and afterwards studied chemistry under Dr. Lyon Playfair in the Museum of Practical Geology, working away at chemistry for a twelvemonth in a laboratory fitted up in the cellar kitchen of a house in Duke Street, Westminster. He then went, in company with Tyndall, to the laboratories of Liebig and Bunsen at Giessen and Marburg. Frankland was appointed Professor of Chemistry in Owen's College in 1851; St. Bartholomew's Hospital in 1857; the Royal Institution in 1863, and the Royal College of Chemistry (now the Royal College of Science), in 1865. He is author of "Researches on the Isolation of the Radicals of Organic Compounds," receiving for the same a gold medal from the Royal Society in 1857; also "On

the Manufacture and Purification of Coal Gas"; "On the Influence of Atmospheric Pressure on the Light of Gas, Candle and other Flames," and "On Researches connected with the Atmosphere of the Sun." An epitome of his work may be found in the "Fifth Annual Report of the Normal School of Science and Royal School of Mines, Session 1884—85," the year of his retirement as professor in that institution. Sir Edward was the first president of the Institute of Chemistry in 1877, received the honour of K.C.B. in 1897, and his merits as one of the most brilliant of our experimental chemists were duly recognized at home and abroad by the bestowal of unstinted honours from many universities and learned bodies.

Notices of Books.

The Indian Eclipse, 1898. Report of the Expeditions organised by the British Astronomical Association to observe the Total Solar Eclipse of 1898, January 22. Edited by E. W. Maunder, F.R.A.S. (London: Hazell, Watson, & Viney. 1899.) Illustrated. 5s. The British Astronomical Association very justifiably takes a pride in the achievements of its eclipse expeditions to India, and the report now issued may be regarded as one of the most valuable of its publications. Beautifully printed and illustrated, ably written and edited for the most part, the volume is one which we found ourselves unable to put down before reading it throughout. There is much that is interesting without being strictly astronomical, much that is instructive on matters connected with eclipses, and a fair proportion of the book deals with the scientific results of the expeditions. The story of the eclipse of 1898 has already been in part made familiar to our readers. Two stations were occupied by the Association; one at Talni by Mr. and Mrs. Maunder, Mr. Evershed, Mr. Thwaites, and others; the other at Buxar, on the Ganges, by the Rev. J. M. Bacon's party. The troubles and pleasures of travel, and the novelty of camp life, are lightly touched upon in the general narratives of the two expeditions by Mr. Maunder and Mr. Bacon respectively, and both writers refer to the interest of watching the new astronomical conditions as the voyage southwards was performed. The camp at Jeur, occupied by Prof. Campbell, Prof. Naegamvala, and others is described by Mr. Cousens, and another chapter is devoted to brief descriptions of photographs of various places of historical or other interest visited by members of the expeditions after the eclipse. One of the most serious chapters is that entitled "Spectroscopic Observations." This opens with an admirable introduction to the special questions and conditions involved in eclipse work, which we commend to all who require a simple explanation of these matters. Mr. Evershed follows with an account of his spectroscopic work, which is illustrated by copies of some of his numerous photographs taken with the prismatic camera, his most valuable contribution to science being, in the judgment of the writer, his splendid impressions of the ultra-violet part of the flash spectrum. Unfortunately, his report breaks off where the real interest for many readers will perhaps commence—that is, in the bearing of the results on solar theory. Mr. Maunder's experiences with the prismatic opera glass will be very valuable to future observers who may employ this exceedingly portable and comprehensive instrument, the possibilities of which were described in the *Journal of the British Astronomical Association* for 1896; the chief result agrees with that obtained from photographs taken at Viziadrug—namely, that the distribution of coronium corresponds with the inner corona and has no obvious connection with the great streamers. Visual and photographic impressions of the corona occupy a considerable part of the volume, and here an attempt is made by Mr. and Mrs. Maunder to discuss the results, which seem to them to indicate a close connection between cometary and coronal phenomena. A full account is given of the wonderful photographs taken with a very modest camera by Mrs. Maunder, showing great extensions of the corona, and the corona itself a considerable interval after totality. The absence of a description of the Buxar animatograph, of reference to its object, and the subsequent misfortunes of the film, leave a curious feeling of incompleteness in this section. Among the miscellaneous observations, described by various contributors, the subject of shadow bands is not the least interesting. It so happens, however, that all the observations were made on a horizontal plane alone, so that they cannot be utilised in some of the inquiries which suggest themselves, and little or no new light is thrown upon their origin. Suggestions for future work enhance the value of the report. We hope to have made it clear that the report is at least very instructive and full of interest. What is badly wanted now is a successor to the late Mr. Ranyard, who would undertake to co-ordinate recent eclipse work in a companion volume to the well-known Vol. XLI. of the *Memoirs of the Royal Astronomical Society*. Until this is done it will be difficult to correctly estimate the value of many observations published in this and other eclipse reports.

In the Australian Bush and on the Coast of the Coral Sea. By Richard Semon. xv. + 536 pp., with eighty-six illustrations and four maps. (London: Macmillan & Co., Limited.) 21s. net. Not every biologist anxious to study oviparous mammals, marsupials and ceratodus, can do as Dr. Semon did in June, 1891. He started from Jena with the intention of spending two years in the Australian bush, in order that, in the first place, he might thoroughly investigate the life-history, and follow the various stages in the embryology, of ornithorhynchus, echidna, and ceratodus; and secondly, if possible, add to the existing knowledge of Australian fauna in general. But, thanks to Dr. Semon's skill in photography, and to his trained powers of observation, to say nothing of his industry since his return to Europe, every zoologist who wishes to extend his acquaintance with the old world forms named above, can, if he will take this handsome volume as a guide, become transported to a completely new environment, and in the company of a charming companion enjoy all the pleasures of a visit to the Antipodes. "In the Australian Bush" is not only a book of thrilling adventure, but, what is far more valuable, it is a well-stocked storehouse, in which new facts concerning animals of unique interest to the student of zoological classification are presented in a scholarly yet eminently readable manner. Dr. Semon regarded his work on the monotremes and that representative of the almost exterminated class of Dipnoi or lungfish, ceratodus, as his principal task. Taking these animals in the same order in which the author deals with them, the duck-billed platypus must be first introduced. The water-mole, as the colonists call it, will be best known to many readers by its scientific name *Ornithorhynchus anatinus*. It is only represented by this single Australian species, and exists nowhere else in the world. For its food it is restricted to the water, and is able to keep under the surface for some time, but not to breathe there, its lungs being as unfit for water breathing as those of all other

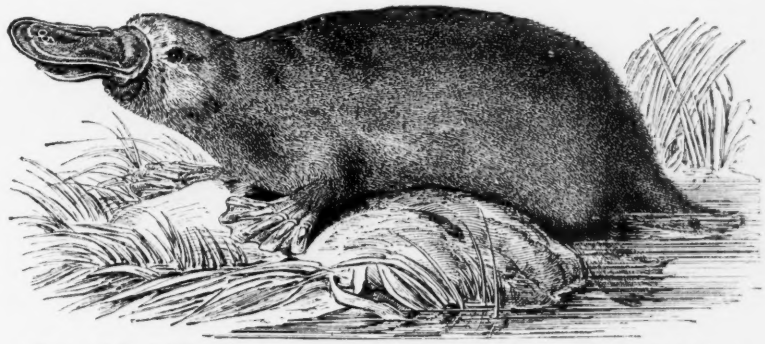

Figure of Duck-billed Platypus (*Ornithorhynchus anatinus*), from "In the Australian Bush." (Macmillan.)

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mammals. It generally remains asleep during the day in its self-built holes within the river banks. When feeding in the mire of a river it rakes up the mud with its flat duck-like beak, or it hunts for grubs, worms, snails, and mussels. These it stows away in its cheek-pouches for future consumption. It is a toothless animal, like echidna. Its thick horny jaws which take the place of teeth are well adapted for cracking mussels and similar food. During the warmer season the ornythorhynchus exclusively uses the nights for its visits to the river in its neighbourhood, and sleeps in its burrows during daytime.

Dr. Semon had to exercise great patience in his search for ceratodus and its eggs. His method of catching the animal, as well as subsequent dissection, completely disproves what has hitherto been believed about the vegetarian proclivities of the Australian lungfish. It limits itself to fresh water. In its general behaviour ceratodus resembles a newt. It has an ally, *Protopterus annectens*, in tropical Africa, which differs from ceratodus, however, in taking a long summer sleep, having first protected itself in a sort of cocoon made out of its own slime. In dealing with echidna, the other oviparous mammal, the author summarises what is known about this member of the monotremata. It is well to remember that its distribution is by no means so limited as that of ornithorhynchus. The brain of echidna is conspicuous for its size, considering the lowly position of the animal in the zoological scale. The animal is itself most remarkable for its excessive shyness, a fact which makes it appear dull and stupid in captivity. Enough has been written to show that the author of this book is justified in hoping that it may prove "a friendly companion to a reader wishing to wile away the leisure hour." We have spent many hours with it, and heartily recommend it to the notice of all who are interested in biology.

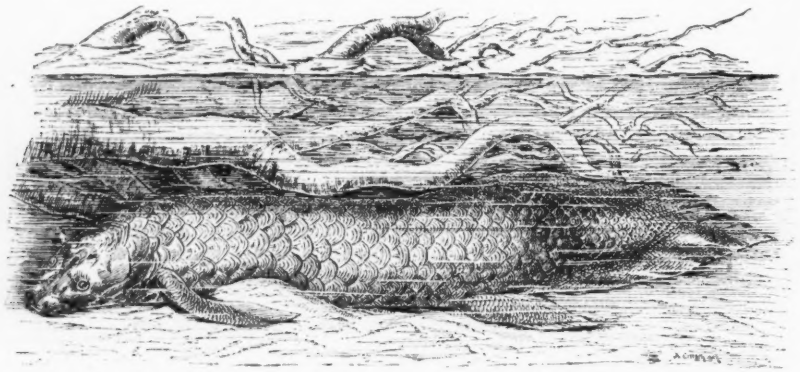

Figure of the Lungfish (*Ceretodus Forsteri*), from "In the Australian Bush." (Macmillan.)

My Tour in Palestine and Syria. By F. H. Deverell. (Eyre & Spottiswoode.) Illustrated. "My," in the title of this work, is a word which, to the author, represents a brilliant triumph—the realization of a dream of youth. To read works of travel in the Holy Land was not sufficient for Mr. Deverell; his religious environment in early life led him to regard a visit to Palestine as "the crowning visit of all possible visits," and we have here a beautiful setting of all his experiences charmingly illustrated with photographs of excellent character. The journey out to Jaffa commenced on the 21st March, 1895, and from thence Jerusalem, the central point of interest, was reached direct by train—a distance of fifty-four miles which occupied four hours; altogether, the tour extended over a period of about two months, and "the journey has, I believe," says the author, "tended to deepen rather than to destroy my previous conception of Palestine's place in universal history, and the Bible's place in universal literature." Being a perfectly independent production, embodying the impressions of a mind deeply imbued with scriptural subjects and written in a tranquil and unvarnished style, the book presents a very realistic picture of the places visited and the people now occupying the country which is of such unparalleled interest to all mankind. Some scientific readers will find matter of value in the meteorological and other natural phenomena observed by the author during his tour and here incorporated.

A Retrospect of Eight Decades. By Rev. Edward L. Berthon, M.D., F.R.A.S. (George Bell & Sons.) Illustrated. 5s. Mainly autobiographical, this book gives us glimpses of many phases of life and the transformations which applied science have effected during the last eighty years. The author, born in 1813, was intended for the medical profession, and ultimately became a clergyman; but, judging from his inventive proclivity, it is probable he would have made a more imposing figure as an engineer. In his book, the main fault of which, if we may term it such, is its brevity, he gives us a vivid impression of a bygone age—the age which preceded steam and electricity, and all those innovations which, taken together, form such a conspicuous line of demarcation between the Victorian era and the centuries, separating us from the ancient civilisations of Greece and Rome. A keen and strictly scientific observer, the astounding stories he tells of surgery as practised in the first half of the century are well calculated to make us thankful for the more rational system which now prevails. Mr. Berthon, among other things, has invented the screw propeller, collapsible boats and pontoons, and portable hospitals.

Early Work in Photography. By W. E. Henry, C.E. (Dawbarn and Ward), has reached a second edition. It is a text-book for beginners, and treats in a very lucid manner the first steps in photography, even introducing an actual positive and negative on celluloid, to aid the tyro in his efforts. The price is 1s. net.

The Journal of the Society of Comparative Legislation. (John Murray.) 5s. The second volume of the new series is remarkable for some short memorial articles on the late Lord Herschell, which have been contributed by Mr. Victor A. Williamson, Lord Davey, Lord James of Hereford, and two others. Of these, the most interesting is the brief appreciation by Lord James of a colleague with whom he served in the arduous work of the Parliament of 1880–85, when Herschell was appointed Solicitor-General, and Sir Henry James, as he then was, became Attorney-General. "Full confidence he gave me—a confidence that enables me to declare that never has a public man more strenuously striven a true part to play and fully his duty to do than did Farrer Herschell." We cannot too highly commend the object of this important periodical in comparing and contrasting the problems of civil and criminal law and procedure as they appear to legislatures other than our own; and the urgent importance of gathering together such material is apparent when we reflect upon the fact that "no fewer than a hundred legislatures in English-speaking countries alone are engaged in experiments more or less instructive."

Our attention has been directed to a new "look-out" telescope, fitted with terrestrial and astronomical eye-pieces, as well as a dark glass for observing the sun, just put on the market by Messrs. Newton & Co. The instrument is provided with a very good three-inch object glass mounted in a forty-two inch brass tube, which is carried on a tripod five feet high. The metal cradle bearing the telescope projects outwards at an angle which admits of a free sweep in altitude, and there is an adapter for rough adjustment of distance, with a rack motion for final focussing. Altogether it is an admirable piece of work. We notice that this firm has opened a new factory in Little James Street.

BOOKS RECEIVED.

Rapport Annuel sur L'etat de L'Observatory de Paris pour L'Année 1898. Par M. M. Loewy.

Forty-sixth Report of the Department of Science and Art, 1899. (Eyre & Spottiswoode.) 1s. 7d.

Remington Typewriter Manual. By R. T. Nicholson. (Pitman.)

On the Physiological Perception of Musical Tone. Boyle Lecture. By John Gray McKendrick. (Frowde.) 1s.

Remarkable Eclipses. By W. T. Lynn. (Stanford.) 6d.

Bird Life in an Arctic Spring. By Dan Meinertzhagen. (R. H. Porter.) Illustrated. 4s. net.

The Studio. August, 1899. 1s.

The Röntgen Rays in Medical Work. Second edition. By D. Walsh. (Bailliére.) Illustrated. 10s. 6d. net.

Proceedings of the Society for Psychical Research. Part XXXV., Vol. XIV. (Kegan Paul.) 5s.

National Competition, 1899—List of Students Rewarded, with the Report of the Examiners.

The Yorkshire Ramblers' Club Journal. Vol. I., No. 1. (Unwin.) 2s.

Introduction to Zoology. By B. Lindsay. (Sonnenschein.) Illustrated. 6s.

The Romance of Wild Flowers. By Edward Step, F.L.S. (Warne.) Illustrated. 6s.

The Photo-Miniature. No. 4, July, 1899. (Dawbarn & Ward.) 6d.

Modern Cremation. Third Edition. By Sir Henry Thompson. (Smith, Elder & Co.)

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Molesworth's Pocket Book of Engineering Formulæ. Twenty-fourth Edition. (Spon.) 6s.

LONDON SUMMERS NEAR SUN-SPOT MINIMA.

By ALEX. B. MACDOWALL, M.A.

THREE stages might perhaps be distinguished in meteorological science:—First: observation and record of phenomena. Second: elucidation of those phenomena, as regards their proximate, terrestrial causes (explaining, *e.g.*, the physics of cyclones, thunder, dew, &c.). Third: reference of weather to periodic changes of the sun or the moon, or perhaps some other outside influences.

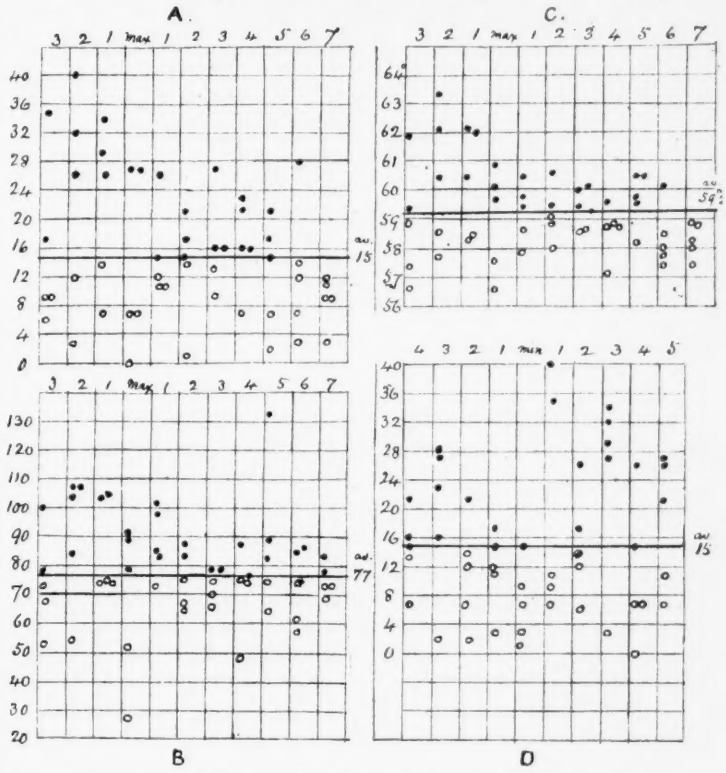
If a beginning may be said to have been made in this third stage of "cosmic meteorology," the amount of undisputed gain to knowledge is not, thus far, perhaps, so extensive and definite as to be of great practical use. Thus it probably occurs to few at present to ask what part of the sunspot cycle has been reached, with a view to getting some clue to the weather of approaching years. Such inquiries may in time, however, prove to be not wholly useless.

The last sunspot maximum occurred in 1894 (by one estimate), and we are now on the downward slope, and probably nearing a minimum. The exact time of this minimum cannot be fixed, but if we consider these dates of minima since 1841—viz., 1843, 1856, 1867, 1879, 1890—we shall probably be not far wrong in looking for a minimum in or about 1901.

Do our summers give any indication of sunspot influence? And does our past experience of summer near sunspot minima give any hint as to what kind of summer weather we might expect near this next minimum? These practical questions we may briefly consider.

The heat of our summers might be measured in various ways. Thus we might count, in each year, the number of days on which the thermometer reached or exceeded a certain limit, say eighty degrees. We might do the same with a lower limit, say seventy degrees. Greenwich supplies tables of such data from 1841, and we shall employ both series. Again, we might find the mean temperature of summer proper—that is, of June, July, August; or do the same with four or five months, including (with summer) May or September, or both. We shall, in a third method, use the mean temperature of the four months, May to August.

In the rough diagrams herewith, A relates to summers as measured by the number of days with the thermometer going up to or beyond eighty degrees. Summers are here "pigeon-holed," so to speak, in eleven columns, according as they fall in a sunspot maximum year, or the year before or the year after, or the second year before or after, and so on; the series extending from the *third* year before to the *seventh* year after, in accordance with the average course of the sunspot cycle (four years of growth, seven years of decrease). Each mark (dot or small o) stands for a summer season, and the distance of each mark from the average line (fifteen days) shows how hot the summer is (dots), or how cool (small o's); that is, how much *more* than the average number of days with thermometer up to or above eighty degrees it had, or how much *less*. Five summers are thus represented in



A. Summers measured by number of days with thermometer 80° or more (max. sunspot group).
B. Summers measured by number of days with thermometer 70° or more (max. sunspot group).
C. Summers measured by mean temperature of May to August (max. sunspot group).
D. Same as A (min. sunspot group).

each column, according to the five sunspot maximum years dealt with.*

Now, we may here be struck by the fact that the hottest summers cluster in the *earlier* years of the series, that is to say, about the time of *growth* and maxima of the spots.

Suppose we draw a line at twenty-four, and call every summer season with more than twenty-four of those days *very hot*. We find twelve such summers, and ten of these are in the first five columns (3, 2, 1, maxima, 1). In the years after maxima are passed, the dots cluster nearer the average line; the summer heat, in fact, is moderated. Coming to the end of the series, *i.e.*, near sunspot minima, we find (6, 7) a large preponderance of *cool* summer seasons.

The same general view seems to be borne out by the diagrams B and C; in the former of which seventy degrees is taken as the thermometric limit, instead of eighty degrees; while in the latter we consider the mean temperature of May to August.

Thus, in the case of B, we find *ten* summers which, having more than ninety days with thermometer up to or over seventy degrees, might be called *very hot*. Of these, as many as *nine* are in the first five columns, and *one* only in the remaining six. True, that one (1865) is the hottest summer of the whole, from the present point of view (with one hundred and thirty-two days), and so presents a curious anomaly. The details of C may be worked out, similarly, by the reader.

Comparing these three diagrams, we may further notice, I think, in years following maxima, a *constriction* (so to speak) of the space covered with marks, from *below* as well as from *above*, towards the average line. In other words, the summers in those years apparently tend to be less extreme in *coolness* as well as in *heat*. (Consider the columns 2, 3, 4, after maxima, in B and C especially.)

Reverting to A, it may be useful to specify those twelve hot summers (as measured); they are 1846, 1847, 1857, 1858, 1859, 1868, 1870, 1876, 1884, 1887, 1893, 1895. The hottest is 1868 (forty days). The seasons 1876 and 1887 form the exceptions to the rule.

Now, the above mode of classification (starting from maximum sunspot years), though adequate as far as it goes, does not quite exhaust the summers since 1841, and slightly fails in regard to minima; it is well, therefore, to supplement it by another, in which we start from *minimum* sunspot years, counting forwards and backwards.

In the fourth diagram, D, we are enabled, taking the same measure of summer heat as in A, to compare the five years *ending* with sunspot minima, with the five years *following* those minima. The result is very much the same—few very hot summers in the former group, and in the latter part of this period of spot decline, a large preponderance of cool summers. But once the minima are passed, and the spots are growing, a number of very hot summers.

It is in accordance with these results that we generally find, in regard to summer rainfall at Greenwich, a preponderance of wet summers in the five years ending with sunspot minima, and a preponderance of dry summers in the five years following minima.

The practical view, then, to which these inquiries point (and it is offered without dogmatism as to sunspot influence, or affirmation of an unvarying law), is that we are at present at a time when cool summers are to be looked for rather than hot ones, and that only after the next sunspot minimum is passed (say 1901, but not certainly), need we prepare for recurrent times of thorough and persistent broiling!*

* That is, 1848, 1860, 1870, 1884, 1894. As there are only four summers since 1894, I have made use of the summers 1842, 1843, 1844, being the fifth, sixth, and seventh after sunspot max., 1837.

THE STORY OF THE ORCHIDS.—II.

By the Rev. ALEX. S. WILSON, M.A., B.SC.

THE butterfly orchises, *Habenaria bifolia* and *H. chlorantha*, are also fragrant; they have greenish-white flowers with very long spurs. The greater butterfly orchid is perhaps the deepest of all our native flowers; its nectary sometimes attains a length of one and a half inches. Its fertilizers are sphinx moths, which alone of all our native insects have a proboscis sufficiently long to remove the nectar. The pale colour of the flower and the absence of markings are also indicative of nocturnal or crepuscular visitors. The rostellum differs from that of the orchids already considered; the two viscid disks are separate and placed at the sides of the entrance to the spur. In this position they may adhere to the moth's proboscis, or to the sides of its head; not unfrequently they are observed attached to its eyes.

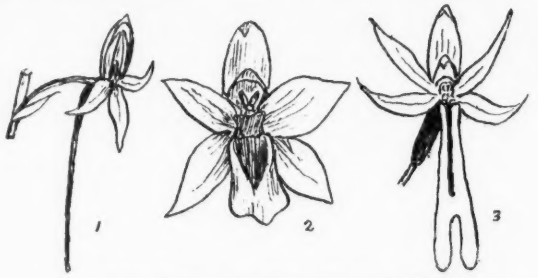


FIG. 4.—1, *Habenaria*; 2, *Epipactis*; 3, *Listera*.

In the fly orchis, *Ophrys muscifera*, the rostellum is also divided, each disk being lodged in a separate cup. The front view of this orchid presents a remarkable likeness to a fly; from this circumstance it gets its name. But the name is appropriate for another reason, for the flower seems to be adapted to carrion flies. The labellum is not spurred, but secretes minute drops of fluid which are gathered by the visitors; the latter as they move upwards come against the rostellum and remove one or both pollinia. Two black shining bodies at the base of the lip are believed by Müller to be pseudo-nectaries intended to deceive certain classes of visitors.

The twayblade, *Listera ovata*, is another orchid frequently met with in woods and pastures. It has yellowish-green flowers, which, as in the previous case, curiously resemble one of its most frequent visitors—a beetle, *Grammoptera levis*. The bilobed labellum hangs down in front; it has no spur, but honey is secreted in a longitudinal furrow. Besides the above-mentioned beetle the twayblade is visited by ichneumon flies. As they creep upwards, licking the honey in the groove, the rostellum is touched and a drop of fluid exudes which instantly hardens and cements the pollinia to the head of the visitor. At the same time the scale-like rostellum bends downwards and protects the stigma from self-fertilization; later on the scale becomes again elevated so that the stigma is once more exposed. The bird's-nest orchid is fertilized in an analogous manner.

Another of these orchids with greenish-yellow, not particularly attractive, flowers is the Helleborine, *Epipactis*

* Up to 19th August, there have been this season, I think, sixteen of these very hot days, eighty degrees and over.

latifolia, remarkable as being visited almost exclusively by wasps. There is no spur, but the concave labellum contains a copious supply of nectar. The square stigma is surmounted by the rather small rostellum; the pollinia, which have no stalks, are both attached to one disk, and are removed together by visitors very much as in the orchids just described. *Orchis pyramidalis* also has but one disk; it is saddle-shaped, and clasps the visitor's proboscis; the curving of the disk causes the pollen-masses attached to it to diverge, whereby they come more readily in contact with the stigmas of the next flower. Self-fertilization occurs extensively in the fly and bee orchises.

A singularly interesting group, the Cypripedinæ, is represented in this country by the lady's-slipper orchid, which occurs (unless it has been recently extirpated) in the north of England. Many species of Cypripedium are cultivated for the sake of their flowers, which are much larger than any of our native orchids, though as a rule they are produced singly, and not in clusters or spikes. Cypripedium differs from the common orchid in several respects. The pollen grains are not combined into pollinia; instead of only one, it has two perfect stamens which belong to the inner whorl, and correspond to the two little swellings at the sides of the fertile stamen of the orchis. The latter is represented in Cypripedium by a large flattened staminode, which partly closes the opening of the lower lip. The lip itself is hollowed out into a kind of pouch in front of the flower. Its upper edges are incurved in such a way that an insect cannot escape by the opening through which it entered. The visitor is consequently forced to crawl up inside the labellum, and squeeze itself through one of the two little holes higher up, where the labellum arises from the column. To reach either of these apertures the visitor must first creep under the stigma. Should there be any pollen on the bee's back this will be transferred to the stigmatic surface. Above each little opening one of the anthers is so placed that the pollen is brushed off by a bee as it makes its escape. This pollen the departing guest will not fail to carry with it when it enters the labellum of Cypripedium. Sand bees have a special liking for this flower, and large insects are occasionally found dead in the labellum, from which they have been unable to escape. The flowers are of various colours — shades of white, yellow, crimson, and pink—according to the species, but the prevailing tint is chocolate brown. A species common in America, with large nodding blossoms of pale crimson colour, is known as the mocassin-flower. The genus has recently been re-arranged into a number of sub-genera, and many species have been re-named.

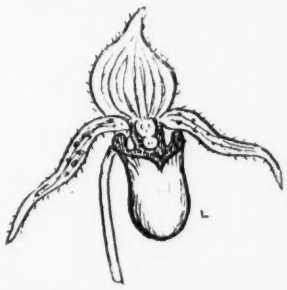


FIG. 5.—*Cypripedium barbatum.*

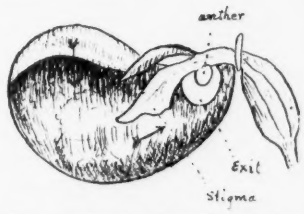


FIG. 6.—Section through Labellum of Slipper Orchid.

One of the Australian orchids, *Pterostylis longifolia*, has a sensitive labellum which acts as a spring trap. When an insect alights it instantly flaps up, and the unwary visitor is entrapped in the flower. There is only one opening above by which escape is possible, and, as happens in Cypripedium, the stigma and anther are encountered on the way out. An irritable labellum also occurs in species of Megaclinium, Bolbophyllum, Drakea, and others. In the vanilla orchid, the pods of which supply the well-known flavouring, an arrangement of hairs, somewhat resembling the mouse-trap hairs of the birthwort, induces visitors to enter and depart in the manner most favourable to cross-fertilization.

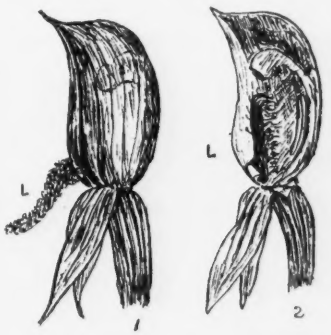


FIG. 7.—(1) *Pterostylis*: (2) with Labellum folded.

ELECTRICITY AS AN EXACT SCIENCE.

By HOWARD B. LITTLE.

V.—ELECTRICAL REASONING AND INCONTROVERTIBLE ELECTRICAL FACT.

SINCE mathematical reasoning and logical truth are the same, all the world over, and in every walk of life, it follows at once that no extraordinary form of reasoning should have been introduced by electrical workers, unless they wished to forfeit their science's claim to be considered exact. A consideration of all electrical laws (and all legitimate deductions therefrom), will render it quite clear that electrical reasoning is, as it should be, no more than the application of the soundest reasoning we know to the immutable laws of the science.

Consider the simplest law that occurs at the moment, "The sum of the currents flowing to a point is equal to the sum of the currents flowing from that point." The "casually inclined" student might perhaps smile, and even say "obvious." And there would be a certain amount of excuse for him in this instance (but bear in mind that a simple rule was purposely selected). Apply Euclid's definition of a point, "That which has no parts and no magnitude." Can any change occur in such a position, when the word position does not imply space? Mathematically, then, it is a statement which may be regarded as an axiom. But the law thus enunciated becomes of real importance when we have to consider that portion of a circuit where one conductor divides into many branches. Here the law of shunts comes in, and we find that the current flowing in each branch or shunt may be represented by a number which is inversely as the resistance of that particular branch, or proportional to the conductivity, where this latter quantity is, of course, expressed as the reciprocal of the resistance.

Once having clearly realised that every electrical quantity is subject to some more or less direct form of measurement, we see that all such quantities may be represented by numbers, these numbers being in their turn regarded as the representatives of so many units. The conception of positive and negative quantities is not so easily arrived at, because we (for some occult reason) adhere to the unfortunate expressions positive potential, and negative potential. These phrases imply to the beginner that there is a difference in quality between the two potentials thus referred to. Nothing of the kind is, however, the case. It has already been pointed out that

the potential of the earth is conventionally assumed to be zero. Why not then bring this to the recollection of the beginner by the use of the complete expression, thus: "The potential of the body is positive with reference to the earth, because, on joining the body to earth, the current would flow from it to earth." We are really compelled to this convention with reference to the earth's potential, and in most cases it is useful, yet here, unless carefully applied, confusion will all too often be the result.

The importance of the algebraic sign must under no circumstances be neglected. A suggestion which I threw out some years ago makes this evident; assume that we wish to measure the resistance of a small part of a circuit, from A to B. We may use a Wheatstone's bridge, or an ammeter and voltmeter. Arrived at the result in ohms, how do we know whether we have been measuring the small portion from A to B, or the remainder of the circuit, which (to preserve our idea of direction) we call B A? Had we wished to measure this latter quantity which we are supposing much greater than A B's resistance, we might have connected up in precisely the same way. Obviously the answer is, consider the signs of the potential difference introduced. This suggestion, calculated to appal the majority of students who have not long been acquainted with the bridge and its use, may be developed. How can one tell that the result is not the resistance in parallel of the two parts of the circuit, modified by the existence of P D's in that circuit, before the bridge was connected? And so on, till it may be made a positive nightmare tending to negative all hope of rest till it be cleared up.

It has been urged that "Reason is the life of the law," and that "Nothing is law that is not reason," yet nearly all unreasonable practices which are widespread amongst electricians in their work are the direct outcome of attempts at legislation concerning matters electrical. While it would serve no useful end to draw attention to specific instances in the past of sheer reasoning power having been brought to bear on some electrical difficulty, yet it cannot be denied that a great amount of thought and subtle reasoning have been required not merely for the perfection of apparatus whose results should be as nearly as possible true mathematically, but also upon systems of electrical generation and distribution which in themselves have formed the life-studies of many vigorous intellects. It is, by the way, more than unfortunate that we should retain as a common expression "generation of electricity," and that we should constantly speak of generators. There is a growing tendency in this direction; in a recent issue of the *Pall Mall Gazette*, a contributor, under the heading "Science Notes," gravely asserts that Joule invented the conservation of energy. But to continue, while all this mental energy, of an order distinctly above the average, has been actually necessary to bring apparatus to its present condition, it must not be forgotten that much of the apparatus in question is used daily in a far more intelligent manner than formerly. To the lay mind one of the most striking instances of the results achieved by electrical reasoning is the fact that should a fault occur on a telegraph line it can be "found" or located from one end of the line, although it may be hundreds of miles away from the individual making the test. And not only can the actual position be fixed, but a good description of the fault can be given by an intelligent operator, and, while remaining perhaps a hundred miles away from the scene of the trouble, he will be able to state, with certainty, that there is a "dead earth," a "partial earth," or a leak, or a break, as the case may be. This must be regarded as a distinct advance, due exclusively to a development in electrical reasoning, because, not more than a few years since, the only known method of finding faults was a search along the line, and the present condition of things must not be referred to improved apparatus, because ten years back, or even twenty, instruments were common which would have enabled the operator to adopt the systems now in use; only, these systems had not yet been thought of.

We have a common saying to the effect that "facts are stubborn things," and scientists who have the courage of their own opinions should be stubborn. Hence, scientific fact has two claims, which may be spoken of as well founded and to be stubbornly incontrovertible. It seems childish to insist that a fact is incontrovertible, but unhappily the necessity exists. So long as a single exponent of the somewhat exclusive science of perpetual motion remains alive, or while the inventor of a primary battery continues to aim at the sale of the said battery to the unfortunate public, for no better reason than that it will cause the filament of a glow-lamp to become incandescent, it is actually the duty of everyone who has made a speciality of scientific study to insist that fact cannot be contradicted, with any hope of success. If upon every housetop in London one were stationed, for eight hours a day, to yell "*ex nihilo nihil fit*," it is yet conceivable that were those words expressed in every language ever heard of, there would remain some who would never hear, and some who would never heed, and some who would contradict.

If we wish to establish the claim of any style of thought, or school of teaching, to be considered scientific, there is one rigorous test which we can apply; ask ourselves, Does such thought and such teaching lead to, and ultimately enunciate, facts which reasoning individuals must admit to be *universally* true? And, do these facts conform with what reasoning beings have already admitted the truth of? To such questioning, electricians can answer boldly, "We are governed in our investigations by laws which it would be actually futile to dispute; and under the guidance of these laws we have been able to contribute largely to the spread of knowledge throughout the civilized world. In our turn, permit us to ask what you would have us do to establish the claim of our study to be considered exact and scientific? Let us also request that the deliberate untruths which are told about us and our work be rigorously suppressed. To ignorance gentle treatment may well be applied, but let those who profess to have attained to an exalted standard of wisdom and popularity (?) keep silent, unless they are prepared to strive honestly for the spreading of truth.

But the Millenium is not yet. When Carlyle was impudent enough to say "Mostly fools," someone whispered "*Tu quoque*," or, if not, someone neglected a distinct duty, and it might have been better to shout. Reverting to those stubborn things which in this connection one is called upon to produce. The telegraph has an existence, so that we get news within a day that would otherwise have taken weeks or months to reach us. We can travel distances in hours which would otherwise take days or weeks. Suppose all the telegraph lines and cables were cut to-morrow. The idea seems appalling, for with the cutting of these lines at first stagnation almost everywhere would result, yet, electricians would be particularly lively, and in something like an hour the majority of the lines would be at work again! If, however, with the cutting of the lines the electricians all died? Well, the world would no doubt stand still for a day or two. And the infant has accomplished all this, just as it would bring into existence a new race of electricians at almost lightning-like rapidity. Further, as the child *must* be

growing up, the new edition would in all probability be a distinct improvement. And when the infant arrives at the hobbledehoy stage, who is going to protect us from his antics? Might it not be wise, for the sake of the community, to legalize infanticide in this particular instance? Already the brat is said to be spoiling the appearance of entire districts, and this because he is past the crying stage. We must protect ourselves.

Perhaps the most striking fact that can with justice be introduced as absolutely electrical is that now "opaque" bodies can be seen through. In this respect, if no other, the child has distanced all the elder members of the family. But why dwell upon this? Our police force must be regarded (like Mr. Meagles' family) as being constituted of "practical people," and they would be amongst the very first to assert that it was quite impossible for them to work if the wires all remained cut.

Endeavouring now to sum the matter up in a more becoming spirit, this much may be asserted, absolutely without fear of contradiction—if suddenly we were to be deprived of everything electrical, our lives would at once undergo a complete change, and this change would, upon the whole, be very much for the worse. Again, and with all possible deference, referring to Democritus, we may glance at a fact which no one hoping to preserve their own reputation for sanity dare dispute; water power where available may be converted into electrical energy, which in its turn may be made use of for the production of light, and the energy dissipated, or allowed to undergo a form of change useless to man, need not be much more than ten per cent. of the amount which must still be considered as having been available. In conclusion, since I am doing my utmost to represent facts quite literally in the latter part of this paper, let me ask for a statement of fact from all who care to give the matter their serious consideration. In what way, other than electrically, can man manipulate any natural force, and, making it subservient to his will, show such an efficiency as this? Finally, the subject in hand is difficult to leave, there is so much that clamours for mention, and it would be absurd to pretend that anything but an arbitrary selection had been made here.

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

SWIFT'S COMET (1899a).—This object will be situated, in September, near the Equator in the extreme north-east part of Virgo, but will be exceedingly faint, the computed brightness being only 0·006−.

TEMPEL'S COMET (1873 II.).—This comet is now invisible to European observers, though it may still be seen from places in the southern hemisphere. It was well seen at Bristol on July 16th and 29th, when it was a fairly conspicuous object in a ten-inch reflector with powers of forty and sixty. The nucleus was placed on the S.S.E. side of the nebulosity, so that it preceded in the direction of motion.

HOLMES'S COMET (1892 III.) is now well situated, but is scarcely an object for ordinary telescopes. When re-discovered by Perrine on June 11th, it was estimated to be no brighter than the 16th magnitude, and since the date alluded to there has been little increase in its apparent brightness. Its light is far more feeble than that computed from its observed appearance in 1892, and Prof. Barnard's idea that the comet owed its origin to some "celestial accident" and would not be seen again has been partially confirmed. Quite possibly its conspicuous and sudden apparition in 1892 was really due to a catastrophe, which imparted a temporary lustre to the object, so it is highly probable that after this return it will have to be relegated to the list of "lost comets." The following is an ephemeris by Zwiers for several days in September :—

Date.	R.A. h.	m.	s.	Dec. °	′	″	Distance in Millions of Miles.
September 5 ...	3	5	53	+ 41	13	30	172
„ 9 ...	3	7	39	+ 42	9	25	170
„ 13 ...	3	8	52	+ 43	3	34	167
„ 30 ...	3	7	29	+ 46	26	25	159

On September 2nd the comet will be about half a degree east of the variable star β Persei, but the lustre of the star will probably obliterate the feeble light of the comet.

THE AUGUST METEORS (PERSEIDS).—The weather was very clear at about the time of the maximum, and a large number of observations have been made. The shower was not unusually rich, nor were the individual meteors of special brilliancy, but the display was fairly conspicuous, and none of those who witnessed it will have cause to complain of scanty results. From the reports already to hand it appears that both August 10th and 11th furnished many meteors (about forty per hour for a single observer), but it is difficult to say when the maximum was attained. Prof. Herschel at Slough, and Mr. T. H. Astbury at Shifnal, Salop, found meteors decidedly more numerous on the 10th than on the 11th, while the writer at Bristol considered the two nights equally productive. But M. Antoniadi, at Juvisy, observed more meteors on the 11th than on the 10th, his comparative numbers being :—

	h.	h.	m.			
Aug. 10—9	to	14	30	G.M.T.	104	meteors, 19 per hour.
„ 11—9	to	14	30	„	138	„ 25 „

In 1898 the maximum occurred on the 11th, and that date certainly furnished a richer display than was observed on any night in 1899. During the recent shower some brilliant Perseids were recorded. At Juvisy, on August 10th, at about 12h. 8m., a magnificent fireball, estimated five times as brilliant as Venus, exploded in Cepheus. At Bristol, meteors rivalling Venus were seen on August 9th, 12h. 7m., August 10th, 10h. 14m., and August 12th, 12h. 1m. The latter left a streak for three and a-half minutes amongst the stars in the northern region of Pegasus. On August 10th, 10h. 31m., Mr. T. H. Astbury at Shifnal, Salop, recorded a Perseid which must have been quite as bright as Sirius, for it gave a very brilliant flash at the end of its flight, and left a streak for twenty seconds.

A preliminary examination of the results sent in by several observers shows that a considerable number of the brighter Perseids have been observed at more than one station. The real paths of all these will be computed as soon as further observations have come to hand and rendered the list more complete.

The minor showers usually contemporary with the Perseids are as interesting as they are numerous. The radiant points of several of these were clearly indicated during the recent display of Perseids, and the most prominent of them, as observed at Bristol, appeared to be as follows :—

Radiant.	Meteors.	Radiant.	Meteors.
16° + 31° ...	4	315° + 79° ...	11
40° + 21° ...	5	332° + 27° ...	8
277° + 70° ...	10	339° − 11° ...	8
293° + 60° ...	8	345° ± 0° ...	9

These and the other secondary streams of the epoch occasionally furnish very conspicuous meteors, and some of them were observed during recent observations at Bristol. Thus on August 12th, at 12h. 31m., an exceedingly slow, yellow meteor of about first magnitude sailed down the northern sky, and occupied about seven seconds in its descent. On August 13th, at 10h. 41m., a meteor about equal to Jupiter passed slowly along the eastern sky, from 29½° + 27½° to 353° + 3½°, and left a bright streak. Its radiant was at 61° + 37°, and proves the meteor to have been an early member of a well-known September shower.

LARGE METEORS.—Prof. Barnard has kindly sent me an account of a large detonating meteor seen at Nashville, Tennessee, on March 6th, 1899, at 17h. 45m. G.M.T. Observers describe the meteor as blinding in the intensity of its light. It appeared slightly to the west of the zenith, and moved through a short path to the west or north-west, where it exploded with a terrific noise which shook the city like an earthquake.

FIREBALL OF AUGUST 4TH.—M. Antoniadi sends a very interesting account, accompanied with a diagram, of a fireball, about five times more brilliant than Venus, which he observed at Juvisy, on August 4th, 9h. 46m. G.M.T. It travelled from

XUM

241¾° + 23° to 218¾° + 25° when it exploded, and finally became extinct in 208° + 22½°. The path, carried far back in the same direction, brings us to the radiant of the July–August Aquarids, and there is little doubt that this brilliant meteor derived its origin from that well-known stream.

Microscopy.

By JOHN H. COOKE, F.L.S., F.G.S.

Canada balsam, one of the most useful of resinous media, is usually slightly acid. In some cases this is a drawback, but for mounting sections stained with carmine, or injected with carmine gelatine, or Berlin blue gelatine, it is advantageous. The balsam may be neutralized by mixing a little carbonate of soda with the thinned solution before it is thickened. The soda settles after a few days and leaves the balsam clear and neutral. Carmine will diffuse, and blue will fade in the neutral balsam.

Thin mica plates are suggested as making good covers for such objects as fish's eggs, frog's eggs, &c. On account of the flexibility of the mica, the egg is less liable to be crushed than with a glass cover, and if the effects of pressure on the development of the egg are to be studied, the mica cover may be easily manipulated.

The preparation of a bone section so as to show the lacunæ, canaliculi and deep seated cells, may be quickly effected by the following method:—Take a fresh bone, and with a strong, sharp knife cut off a thin shaving. Immerse the section in carmine dissolved in ammonia, the ammonia being first neutralized by acetic acid. The walls of the vessels which penetrate the lacunæ and canaliculi are by this means stained crimson, and the true structure of the bone is thus rendered visible.

A solution of gum-dammar in xylol is more suitable than Canada balsam as a mounting medium for rock sections.

To render micro-photographs self-luminous soak them in castor-oil to make them transparent, and dust them over with powdered sulphate of baryta or sulphite of lime. When dry mount them on cardboard of a suitable size with starch paste. The phosphorescence of the salt lights up the photograph.

Drying oils in every form, such as gold size, paint, etc., becomes hard by oxidation, and not, as is generally supposed, by evaporation. The drying process is frequently a long one. Where time is an object, as in class demonstrations, it may be expedited by placing the slides in a small chamber (a porcelain dish answers admirably) and passing over them a stream of oxygen obtained by the decomposition of potassium chlorate.

A saturated solution of bichloride of mercury, to which has been added one per cent. acetic is an excellent medium for killing specimens of the protozoa on the slide or cover preparatory to mounting. In some cases a hot solution is useful, as being more rapid in its results, and producing little or no deformity of the cells.

It is a pity that amateur microscopists do not more fully recognize the necessity of recording, to some uniform and convenient scale, the dimensions of the microscopic objects that they make their study. This want of uniformity not only detracts from the value of the work done, but it also renders the work of comparison of the drawings of the objects laborious and unreliable. By operating on some object of known size it is easy to ascertain what arrangement of the microscope, and of its objectives and ocular, is necessary to obtain an image with the camera lucida of any required size. Having determined on a given amplification it should be adhered to, and a scale be made corresponding to this amplification. The actual dimensions of the object might then be readily ascertained by applying this scale to the various parts of the image or drawing. The value of some such uniform method as this is self evident.

To prevent sand grains and other loose objects from being forced out from under the cover-glass when mounting, Mr. H. C. Sorby recommends that the objects should be well mixed with weak gum and water, the gum to be of such a consistency as to make it easy to separate the grains and spread them uniformly over the space which will afterwards be covered by the cover-glass. The water is then allowed to evaporate slowly. Much of the gum may collect around the margin, but by properly regulating the quantity originally added, enough will remain under the larger grains to hold them so fast that they will not be squeezed out in the excess of balsam.

Dr. Marpmann, of Leipsic, has recently published the results of his microscopical examinations of sixty-seven samples of ink used in schools. Most of these inks were made with gall nuts, and contained saprophytes, bacteria, and micrococci. Nigrosin ink taken from a freshly opened bottle was found to contain both saprophytes and bacteria. Red and blue inks also yielded numerous bacteria. In two instances he succeeded in cultivating from nigrosin ink a bacillus which proved fatal to mice in four days. This ink had stood in an open bottle for three months, and the inference to be drawn from the enquiry is that ink used in schools should always be kept covered when not in use.

The current issue of the *Transactions of the American Microscopical Society* contains *inter alia* a valuable article on "Freshwater Investigations during the Last Five Years," by Dr. H. B. Ward, of Nebraska. It includes a bibliography of every article, however small, that has been published on plankton work since 1893, and it is therefore of great practical value to those who have taken up this field of work.

In the same publication, Dr. T. E. Oertel describes a convenient method for preparing nucleated blood in bulk for class demonstration. No book on microscopical technique has given details of preparing blood so as to yield absolute uniformity in results. "Smears" are not as a rule satisfactory by reason of the agglutination or crenation of the corpuscles, excess of serum, and the formation of fibrin. Dr. Oertel's contribution is therefore of considerable practical value, inasmuch as it obviates all of these defects. His method is, briefly, as follows:—Select a large frog, chloroform it, open the thorax, puncture the aorta and allow the blood to flow directly into a small glass jar containing a one per cent. aqueous solution of osmic acid in the proportion of one of blood to fifty of the solution. Allow the cells to settle, decant the supernatant fluid and add distilled water. Repeat this process, after which add Böhmer's hæmatoxylin diluted one-half with distilled water. After a few moments' staining, filter; wash filtrate from the paper and pass through the various grades of alcohol, beginning with seventy per cent. and finishing with absolute. Clear in carbol-xylol, and after drawing off as much of the liquid as possible add thin xylol balsam. Keep in a well-stoppered bottle, and when required for use transfer a drop with a glass rod to the slide, and super-impose a cover-glass. A neat and permanent preparation is the result.

THE FACE OF THE SKY FOR SEPTEMBER.

By A. FOWLER, F.R.A.S.

THE SUN.—On the **1st** the Sun rises at 5.14, and sets at 6.46; on the **30th** he rises at 6.0, and sets at 5.40. He enters Libra, and autumn commences, at 6 o'clock on the morning of the **23rd.**

THE MOON.—The Moon will be new on the **5th,** at 3.33 A.M.; enter first quarter on the **12th,** at 9.49 P.M.; will be full on the **19th,** at 12.31 P.M.; and enter last quarter on the **26th,** at 3.3 P.M. Two or three days before and after full the Moon rises nearly at the same time, thus giving us the well-known phenomena of the Harvest Moon.

The sixth magnitude star, 39 Ophiuchi, will be occulted on the **12th**; the disappearance will take place at 8.47 P.M., at 28° from the north point (2° from the vertex), and the reappearance at 9.26 P.M., at 318° from the north point (287° from the vertex). The Moon sets at 9.33 P.M.

THE PLANETS.—Mercury is a morning star throughout the month, and during the first part is very well placed for observation. He will be at greatest westerly elongation at 7 A.M. on the **5th**, but as the planet is at perihelion on the **9th**, the angular distance from the Sun only amounts to 18° 2′. Still, the apparition is specially favourable for our latitudes because of the great inclination of the ecliptic to the horizon near the time of sunrise at this time of the

year, as shown in accompanying diagram. At the most favourable time, on the **5th**, he rises something like an hour and three-quarters before the Sun; about an hour before

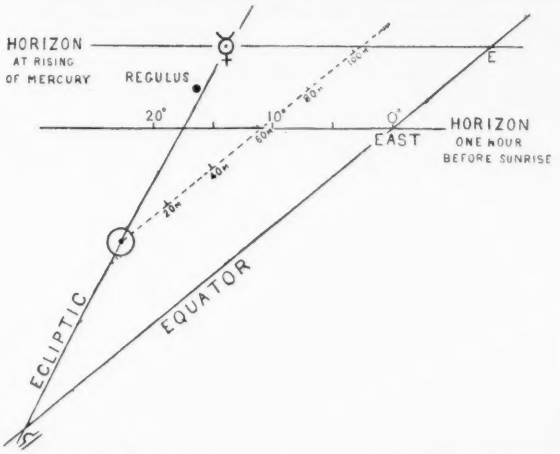


Diagram to illustrate favourable conditions for seeing Mercury as a morning star on September 5th. The dotted scale represents intervals before sunrise, and the horizontal scale shows amplitude north of east.

sunrise the planet will be some 14° north of east, and between six and seven degrees above the horizon. On the morning of the **3rd** he will be at or near the same altitude as the crescent Moon, and only about 4° to the left, a circumstance which may assist in identifying the planet.

Venus is badly placed for observation. She is a morning star until the **16th**, when she will be in superior conjunction with the Sun.

Mars is an evening star in Virgo, but he sets too soon after the Sun, and is too far away, for useful observation.

Jupiter is also an evening star, but is too near the Sun and too low to be easily observed. It is only under specially favourable conditions that any of the satellite phenomena can be observed this month. The planet is between Virgo and Libra, in the west, in the early evening.

Saturn is still in the southern part of Ophiuchus, and may be observed in the early evening low down in the south-west. He will be in eastern quadrature on the **10th**. About the middle of the month he sets shortly before 10 P.M.

Uranus is not observable.

Neptune may be picked up in the eastern sky by diligent observers. He is in western quadrature on the **20th**, and stationary on the **30th**. His path lies in the Milky Way, in the eastern part of Taurus, and the difficulty of identification is, therefore, considerable, especially as he is near a stationary point. He is about 15m. following, and 1° 3′ north of ζ Tauri.

THE STARS.—About 10 P.M. at the middle of the month, Auriga and Perseus will be in the north-east; Taurus low down a little north of east; Aries, Andromeda, and Cassiopeia towards the east; Pisces a little south of east; Cetus low down from east to south-east; Pegasus south-east; Aquarius and Capricornus nearly south; Cygnus almost overhead; Aquila and Lyra nearly south-west; Hercules in the west; Corona and Boötis to the north of west; and Ursa Major nearly due north.

A conveniently observable minimum of Algol occurs on the **17th** at 8.34 P.M. A maximum of Mira Ceti is due in the early part of the month.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and should be posted by the 10th of each month.

Solutions of August Problems.

No. 1.

(By Rev. E. Cowley.)

Key Move—1. Q to Kt7.
If 1. . . . K to K6. 2. Q to Kt4, etc.
1. . . . K to K5. 2. R to KB2, etc.
1. . . . K to B5. 2. R to KB2ch, etc.

No. 2.

(By W. Clugston.)

1. B to Kt7, and mates next move.

CORRECT SOLUTIONS of both problems received from Alpha, E. Servante, G. A. Forde (Capt.), W. de P. Crousaz, G. C. (Teddington), A. H. Doubleday, H. S. Brandreth (Cauterets), K. R. B. Fry, K. W., H. Le Jeune, N. M. Munro, J. Baddeley.

Of No. 1 only, from W. H. Jones (variations incorrect).

Of No. 2 only, from Charles Savage, F. B. L. (Devonport), and W. H. Wesley.

W. H. Jones.—After 1. R to QB4ch, K to B6; 2. B to QKt7ch, the Black Pawn can interpose.

G. D.—No qualification is necessary for solving the Chess problems in KNOWLEDGE. Those sent by you this month are unfortunately incorrect. In No. 1, 1. K to Q5 is met by 1. . . . K to Kt6, not Kt5, in which case there is a mate in two moves by 2. R to R3 as you suggest. Nor will 1. B × P solve No. 2, on account of the subsequent interposition of the Black KP.

P. G. L. F.—Thanks for the problem; it appears below.

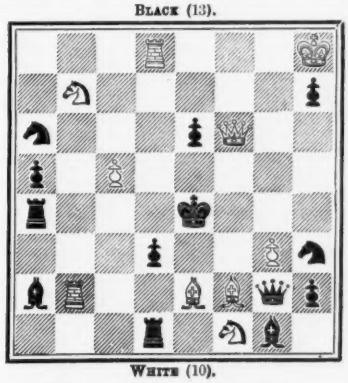
Gustav v. Bröcker.—We regret that the programme is not intelligible to us.

PROBLEMS.

No. 1.

(From *Chess Miniatures*, by H. Bristow.)

BLACK (13).



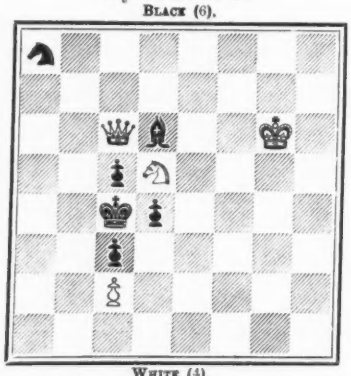
WHITE (10).

White mates in two moves.

No. 2.

By P. G. L. F.

BLACK (6).



WHITE (4).

White mates in three moves.

CHESS INTELLIGENCE.

"Chess Miniatures" is the title of a collection of fifty two-move chess problems by Henry Bristow. Some of Mr. Bristow's problems have appeared in this column before this. Though occasionally a little too exuberant in the matter of forces, they are always full of point, and generally exhibit considerable originality. The booklet, which is "the first production of an amateur printer," and, as such, certainly very creditable, may be obtained from the author, 16, Wesley Terrace, Hyde Park Road, Mutley, Plymouth. The price, post free, is 1s.

The British Chess Company, Stroud, Gloucestershire, offer to supply, gratis, to any chess club or reading room a copy of the rules of the British Chess Code, mounted on linen (about twenty inches by sixteen), suitable for hanging on the wall.

Messrs. George Routledge and Sons are the publishers of the "Modern Chess Primer," by the Rev. E. E. Cunnington, M.A. (Price 1s. 6d. boards, or 2s. cloth.) This is an extremely useful handbook for beginners. The feature of the book lies in the fact that the writer has succeeded in looking at the game from the standpoint of the beginner, and not, as is too often the case, from his own point of view. The writer takes the whole of chess for his province, and the three hundred and fifty pages are most usefully filled. The moves of the men, and the various notations are first explained; then numerous examples of check-mates are given, including both standard ending check-mates, and mates of the kind likely to occur during the middle-game in actual play. Pawn play is next considered, and there in an instructive chapter on traps and stratagems. The openings occupy about thirty-five pages; then follow general hints, annotated games and end games, and about thirty problems. A brief history of chess and chess literature leads to the British Chess Code at the end. Perhaps the most useful novelty is the chapter on easy check-mates in two or three moves. We ourselves recently composed a collection of "Check-mates on a Castled King," showing the most likely ways of bringing the middle game to an abrupt termination. Some of Mr. Cunnington's mates are naturally the same, or similar; but some of them strike us rather as ordinary problems, the Black King often being in the centre, than as mating positions likely to occur in actual play. The games are very well annotated for beginners, the objects of the various moves being clearly explained. On the whole, the book strikes us as the best introduction to chess which has yet appeared.

Game played in the London Tournament.

"Queen's Gambit Declined."

WHITE. (Janowski.)	BLACK. (Maroczy.)
1. P to Q4	1. P to Q4
2. P to QB4	2. P to K3
3. Kt to QB3	3. Kt to KB3
4. B to B4	4. B to Q3
5. B to Kt3	5. Castles
6. P to K3	6. P to QKt3
7. R to Bsq	7. B to Kt2
8. P×P	8. B×B
9. RP×B	9. P×P
10. B to Q3	10. P to KR3
11. P to KKt4	11. R to Ksq
12. P to Kt5	12. P×P
13. Kt to B3	13. P to B4
14. Kt×KtP	14. P×P
15. R to R8ch	15. K×R
16. Kt×BPch	16. K to Ktsq
17. Kt×Q	17. R×Kt
18. Kt to Kt5	18. P×P
19. Kt to B7	19. P×Pch
20. K×P	20. Kt to B3
21. Kt×R	21. B×Kt
22. Q to R4	22. Kt to K4
23. B to B5	23. Kt to K5ch
24. K to Ktsq	Resigns.

KNOWLEDGE, PUBLISHED MONTHLY.

Contents of No. 165 (July).

Sponges and the Sponge Trade. By R. Lydekker. (*Illustrated.*)
The Energy of Röntgen Rays. By Dr. J. G. Macpherson, F.R.S.E.
The Story of the Orchids.—I. By the Rev. Alex. S. Wilson, M.A., B.SC. (*Illustrated.*)
Microbes in Co-operation. By G. Clarke Nuttall, B.SC.
Distribution of Stars in Space. By Gavin J. Burns, B.SC. (*Diagrams.*)
The Zodiacal Coins of the Emperor Jahängir. By E. Walter Maunder, F.R.A.S. (*Plate.*)
Galileo's Tower at Florence. By W. Alfred Parr. (*Illustrated.*)
Science Notes.
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The Mycetozoa, and some Questions which they Suggest.—IV. By the Right Hon. Sir Edward Fry, D.C.L., LL.D., F.R.S., and Agnes Fry. (*Illustrated.*)
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Microscopy. By John H. Cooke, F.L.S., F.G.S.
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The Face of the Sky for July. By A. Fowler, F.R.A.S.
Chess Column. By C. D. Locock, B.A.
PLATE.—Zodiacal Coinage of the Emperor Jahängir.

Contents of No. 166 (August).

On the Treatment and Utilization of Anthropological Data.—IV. Height. By Arthur Thomson, M.A., M.B.
The Karkinokosm, or World of Crustacea.—X. Weapons and Wiles. By the Rev. Thomas R. R. Stebbing, M.A., F.R.S., F.L.S., F.Z.S. (*Illustrated.*)
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Chess Column. By C. D. Locock, B.A.
PLATE.—A Contrast in Noses.

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